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NET VALUE OF TROUT FISHING OPPORTUNITIES IN TENNESSEE TAILWATERS

A Final Report Submitted to the Tennessee Wildlife Resources Agency

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Abstract

The consumer surplus or net economic value of trout fishing opportunities in eight Tennessee tailwaters was estimated using the travel cost method (TCM) and the contingent valuation method (CVM). In addition to estimating net benefit under current conditions, the CVM was also used to examine changes in net value under two hypothetical management scenarios: an increased chance of catching more trout and an increased chance of catching a large (> 406 mm total length) trout. Trout anglers (n = 2,570) were contacted on-site at each of the tailwaters between January 2001 and January 2002. Trip expenditures ranged from $29/angler on the South Fork of the Holston River to $149/angler on the Obey. Total expenditures over comparable 6-month periods ranged from $148,213 on the Elk River to $1.5 million on the Hiwassee River. TCM estimates of net value ranged from $7.35/angler/day on the Clinch River to $17.90/angler/day on the Caney Fork River. Total net value over comparable 6-month periods ranged from $34,639 for the Elk River to $485,875 for the Caney Fork River. Total value (expenditures plus net value) over a 6-month fishing season was highest at the Hiwassee and Caney Fork Rivers ($1.7 - $1.8 million) and lowest at the Elk ($182,852) and Duck ($470,960) Rivers. CVM estimates of net value for current conditions were consistently higher than TCM estimates at the same fisheries and ranged from $42.27/angler/day on the Duck River to $91.69/angler/day on the Watauga River. CVM results indicated that anglers at five tailwaters would receive a greater increase in net benefit from the "large trout" scenario than they would under the "more trout" scenario. The exceptions to this were the Watauga River and the South Fork of the Holston River, where anglers indicated a higher willingness to pay for catching more trout, and the Hiwassee River where the two management scenarios were valued equally.

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FOREWORD

This final report is based on a thesis prepared by the senior author in partial fulfillment of the Master of Science degree in the Department of Biology at Tennessee Technological University.

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INTRODUCTION

Fishery managers must increasingly decide how to allocate scarce resources among various management programs. Knowledge of the economic value of various fisheries is necessary in making such cost-benefit analyses. However, a major problem encountered when attempting to value natural resources is the fact that they are nonmarket goods. In neoclassical economics, a good is sold in an organized market for a price determined by that market. This price is a measure of the value of the good to the various participants in the market (Bach 1974). The effectiveness of a market in establishing a price is dependent on the excludable and rival nature of private goods (Peterson and Cordell 1991). Only those individuals willing to pay for a private good may enjoy the benefit derived from that good. All individuals unwilling to pay the set price are excluded from that benefit. Consumption of a private good by an individual prevents the use of that good by other people. This illustrates the rival nature of private goods. In contrast, the benefit derived from a public good such as a sport fishery may be enjoyed by many anglers at once. The nonexclusive and non-rival properties of public goods result in market failure and the inability of the market to establish a price (Swanson and McCollum 1991).

In the past, angler expenditures have been used as a measure of value (Pollock et al. 1994). However, the amount of money an angler spends to participate in a fishing experience does not fully represent the value of the experience to the angler. The difference between the benefit derived from the experience and the cost incurred by the angler is known as consumer surplus or net value. Stated another way, net value for recreation is the willingness to pay over and above actual expenditures. Figure 1 shows generalized supply and demand curves for a fishery. The number of trips taken by anglers is on the horizontal axis and the angler's cost for making a trip is on the vertical axis. The demand curve suggests that as the cost of making a trip increases, the number of trips taken by anglers will decrease. Because the number of fishing opportunities a management agency can supply is assumed to be independent of the cost to anglers, the supply curve is horizontal (Pollock et al. 1994). At a cost P, anglers would take Q number of trips and the rectangle OPTQ represents the total expenditures that would be generated. It is this value that is often used as an estimate of the value of a fishery. However, the demand curve shows that there is a higher cost W that anglers would be willing to pay before they would forego a trip. The triangle PWT is consumer surplus, which signifies the benefit anglers receive from an angling experience over and above their cost to participate.

Consumer surplus can be used as an effective measure of value but will only exist if there are no perfect substitutes, or if available substitutes are higher priced or of inferior quality (Peterson and Cordell 1991). Several methods have been used to measure the net value of nonmarket goods. The two most widely used and accepted methods are the travel cost method (TCM) and the contingent valuation method (CVM).

The travel cost method measures the amount of money that individuals spend in travel to a recreation site and uses that value as a surrogate for price. The TCM is based on the assumption that, other factors held constant, the number of trips taken to a site decreases as the cost of traveling to that site increases (Pollock et al. 1994). A common

form of the travel cost method is the zonal TCM. This technique uses visitation data from distance zones surrounding a site to estimate demand. The first step in the zonal TCM is the construction of a first-stage demand curve, which plots the per capita visitation rates of various distance zones against the respective distance traveled by anglers from that zone. This first stage demand model can then be used to create a site demand curve, which plots total expected trips to the site as a function of added cost. Calculating the area under the site demand curve yields an estimate of total net benefit (in dollars) received by visitors to the site.

Brown and Nawas (1973) warned against using zonal averages instead of individual observations when assessing demand. Inefficient parameter estimates for the demand equation could result from multicollinearity among variables when data are aggregated. This is primarily an issue when the objective is to determine the effect of an individual variable. If individual observations are to be used, they should be expressed on a per capita basis (Brown et al. 1983).

Total travel cost includes both trip-related expenditures and the cost of time spent traveling to a recreation site (Pollock et al. 1994). Cesario (1976) suggested that the value of time ranges between 25% and 50% of the wage rate for adults and is approximately 8% of the wage rate for children. Excluding the value of time will lead to an underestimation of demand and, ultimately, net value (Cesario and Knetsch 1970). It has been suggested that the value of time spent in recreation should also be included when measuring consumer surplus (McConnell 1975; Wilman 1980). Knetsch and Cesario (1976) argue, however, that the value of time spent in recreation does not influence an individual's decision to visit a site and should not be included.

Within the general framework described above for the TCM, there has been much discussion on the exact procedures to follow in construction of both the first-stage and second-stage demand curves. Swanson and McCollum (1991) suggested that other variables in addition to travel cost may affect visitation rate and that these factors should be included when explaining visitation. These factors can include socioeconomic characteristics, site quality, and the cost of substitutes. Site demand, and therefore consumer surplus, can be overestimated if the effect of substitutes is not considered.

There has also been much debate on the functional form of the TCM demand equations. Nonconstant error variances may occur if a linear model is used to determine demand for zones of unequal population (Bowes and Loomis 1980). This nonconstant variance may result in inefficient parameter estimates. Several alternatives to a linear model with ordinary least squares parameter estimates have been proposed, including weighted least squares and transformations of the dependent and independent variables (Bowes and Loomis 1980; Zeimer et al. 1980; Strong 1983).

Contingent valuation uses hypothetical questions to directly estimate the maximum willingness to pay (WTP) of users for an existing resource (McCollum et al. 1990; Connelly and Brown 1991). This method may also be used to determine a gain or loss in net value resulting from changes to the resource (Sorg et al. 1985; Dalton et al. 1998). Continuous CV models involve a type of bidding process in which respondents are asked if they would be willing to pay successively higher amounts for a given scenario until a maximum willingness to pay is reached. The primary issue with continuous models is starting point bias. WTP estimates may be higher or lower than actual values depending on where the bidding began (Pollock et al. 1994). An alternative

to using continuous models is the use of a dichotomous CVM. Individuals are asked if they would be willing to pay a discrete amount and their responses are coded "0" for no and "1" for yes. Using logit analysis, maximum WTP can be determined by examining the probability that an individual will pay a given amount (Loomis 1988). Proponents of the dichotomous CVM suggest that this method more closely resembles consumer behavior and is, therefore, more appropriate for economic analysis.

Although the contingent valuation method is the most common technique used today, critics have voiced several concerns (Pollock et al. 1994). The first concern involves the hypothetical nature of the questions being asked. Respondents might not know exactly how much they would be willing to spend in a hypothetical scenario. Bishop et al. (1995) discussed the importance of defining the good, the payment mechanism, and the context of valuation in ensuring scenario validity. The CVM question should describe the various attributes that make up a good, as well as the source and certainty of proposed changes in these attributes. Definition of a good is sometimes difficult with recreational opportunities and should be carefully considered (Driver 1985). The mechanism by which an individual's willingness to pay is to be expressed must also be carefully considered. Certain payment vehicles, such as taxes or fees, might be perceived negatively by anglers and may, in turn, influence their response. For this reason, a neutral payment vehicle, such as travel cost, is preferable. Another concern with the CVM is what is known as strategic bias. An individual might undervalue his or her willingness to pay in the belief that is in their best interest to do so.

The Tennessee Wildlife Resources Agency (TWRA) currently manages portions of several rivers below major dams as coldwater trout fisheries. Managers identified a need for current and accurate information on the economic value of each of these fisheries to aid them in efficiently allocating resources among the various projects. Such information can also assist TWRA in project justification. This thesis addresses the following research objectives:

1. Describe angler and trip characteristics for trout fisheries in eight Tennessee rivers.

2. Estimate the net value of trout fishing opportunities in eight Tennessee rivers using the travel cost method.

3. Estimate the net value of trout fishing opportunities in eight Tennessee rivers using the contingent valuation method.

4. Estimate the net value of different management strategies using the contingent valuation method.

STUDY AREAS

Caney Fork River

Center Hill Dam is located on the Caney Fork River in DeKalb County, Tennessee, at river mile 27. The U.S. Army Corps of Engineers (USACE) constructed the dam in 1948 for the purposes of flood control and hydroelectric power generation. The dam's three turbines each have a discharge capacity of 100 m^3/s with a combined discharge of approximately 350 m^3/sec. A base flow of 2.55 m^3/s is maintained during periods of no generation by seepage from Center Hill Reservoir. Although water temperatures remain suitable for trout during the summer months, they become hypoxic in early fall.

Fishing pressure over eight months in 1997 was estimated at approximately 66,000 hours, representing 21,300 trips (Devlin and Bettoli 1999). In 2001, the Caney Fork River was stocked with 108,176 catchable ($\geq$ 200 mm total length (TL)) and 64,800 fingerling rainbow trout. About 70,000 fingerling brown trout were also stocked in 1997.

Clinch River

Norris Dam is located on the Clinch River in Anderson and Campbell Counties, Tennessee, at river mile 80. Each of the dam's two turbines is capable of a maximum discharge of 114m^3/s. Early attempts at improving dissolved oxygen (DO) concentrations were largely unsuccessful. In 1995, the turbines were replaced and fitted with an autoventing system, which maintains DO concentrations above 6 mg/L. reregulation weir dam, constructed in 1984, provides a minimum flow 5.7m^3/s.

Over 20,000 catchable brown trout and 57,959 fingerling brown trout were stocked in the Clinch River during 2001. The river also received 33,300 catchable and 160,049 fingerling rainbow trout in 2001. Between March 1996 and March 1997, fishing pressure in the Clinch River was estimated at 98,957 h, or 32,129 trips (Bettoli and Bohm 1997).

Duck River

Normandy Dam is located on the Duck River at river mile 249. Unlike the other dams involved in this study, Normandy Dam is not a hydroelectric-generating facility; therefore, the tailwater does not experience the large, daily fluctuations in flow common in the other tailwaters. Dissolved oxygen levels are maintained above 4mg/L by routing discharged water through a regulated sleeve valve. Despite a guaranteed year-round minimum flow of 1.13 m^3/s, downstream water temperatures often exceed 22 °C.

Fishing pressure over six months in 2000 was estimated at approximately 20,089 h, representing 9,000 trips (Bettoli 2001a). In 2001, the Duck River was stocked with 51,000 catchable rainbow trout. No brown trout were stocked in the Duck River in 2001.

Elk River

Tims Ford Dam is located on the Elk River in Franklin County, Tennessee, at river mile 133. The dam is equipped with a single turbine capable of discharging 100m^3/s at full generation. A minimum flow requirement was established in 1993, which guaranteed a nongeneration minimum flow of 1.6 m^3/s. A smaller hydropower unit supplies this minimum flow. The main turbine was fitted with an oxygen injection system and blowers to increase DO concentrations to 6.0 mg/L. An oxygen injection system and three compressors were installed on the minimum flow turbine to raise DO concentrations to 9.0 mg/L. Bettoli and Besler (1996) found that water temperatures directly below Tims Ford Dam ranged between 8.0 °C and 12.6 °C, but water temperatures at Old Dam Ford, the most downstream site where fish are stocked, were between 11.0 °C and 23.0 °C.

Fishing pressure over seven months in 2000 was estimated at approximately 7,858 h, representing 2,786 trips (Bettoli 2001b). In 2001, the Elk River received 10,000 catchable brown trout and 33,000 catchable rainbow trout.

Hiwassee River

Appalachia Dam is located on the Hiwassee River in Cherokee County, North Carolina, at river mile 66. Discharge from the dam is piped to the Appalachia powerhouse located approximately 9 mi downstream in Polk County, Tennessee. The powerhouse's two turbines are capable of releasing approximately 80 m^3/s at full generation. High water temperatures and low dissolved oxygen levels in late summer and early fall prompted the establishment of a year round minimum flow (6 m^3/s) in 1991 and the installation of hub baffles on the turbines in 1993.

Fishing pressure between February and November 1999 (42 weeks) was 73,842 h, representing 20,761 trips (Luisi and Bettoli 2001). In 2001, the Hiwassee River below Appalachia powerhouse was stocked with 96,215 catchable rainbow trout and 11,679 brown trout fingerlings.

Obey River

Dale Hollow Dam was built in 1945 on the Obey River in Clay County, Tennessee, at river mile 80. The dam is equipped with three turbines, each with a maximum discharge of about 50 m^3/s. Dam operations provide for a minimum flow of 0.7 m^3/s. When DO levels in the discharge drop below 2 mg/L, the turbines are half-loaded in order to aerate the water. At present, no other provisions are made to increase DO concentrations, although the USACE has been the evaluating the use of hub baffles to improve water quality.

Fishing pressure between March and October 2001 was 27,945 h, representing 10,914 trips (Bettoli 2002). The Obey River below Dale Hollow Dam was stocked with 5,000 catchable brown trout and 60,000 catchable rainbow trout in 2001.

South Fork of the Holston River

South Holston Dam is located on the South Fork of the Holston River in Sullivan County, Tennessee, at river mile 50. The dam was constructed by the Tennessee Valley Authority for the purposes of flood control and hydroelectric power generation. South Holston Dam is equipped with a single generating turbine capable of discharging about 68 m^3/s. In 1991, an aerating weir dam was constructed to provide a base flow of 2.5 m^3/s. Substantial natural reproduction of brown trout, and to a lesser degree rainbow trout, has been observed in the South Fork of the Holston River (Banks and Bettoli 2000).

A 12-month creel survey in 1997-1998 estimated angling effort at 110,000 hours or 29,000 trips (Bettoli et al. 1999). In 2001, the South Fork of the Holston River was stocked with 4,457 catchable and 17,505 fingerling brown trout. During this same period, the tailwater was stocked with 73,913 fingerling and 47,675 catchable rainbow trout.

Watauga River

Wilbur Dam is located 2.5 mi below Watauga Dam on the Watauga River at river mile 34. Coordinated discharge pulses from both Watauga Dam and Wilbur Dam maintain a minimum flow of 3.0 m^3/s below Wilbur Dam.

The 16 mi of the Watauga River managed for trout is located between Wilbur Dam and the town of Watauga. During 2001, the Watauga River was stocked with 13,905 fingerling brown trout, 50,751 catchable rainbow trout, and 99,168 fingerling rainbow trout. The Watauga River is the only tailwater involved in this study that was stocked with brook trout (n = 22,875). Bettoli (1999) estimated angling pressure on the Watauga River between March and November 1998 (32 weeks) at 65,118 hours, or 20,564 trips.

METHODS

Data were obtained by means of a roving angler survey at each of the eight tailwaters for a period of twelve months beginning in January 2001. Three weekdays and three weekend days were randomly selected each month. The portion of the day to be worked (sunrise to midday; midday to sunset) was chosen randomly.

The survey clerks began their shifts at the access point nearest the dam. Anglers were approached and asked if they would be willing to take part in the survey. If they agreed to participate, they were given the survey (Appendix), which included demographic questions and questions designed to gather data for the travel cost and contingent valuation methods. For the question pertaining to angler income, anglers were shown a card with the income categories listed and asked to choose the letter that best corresponded to their 2000 annual household income. After all anglers at a particular access point were interviewed, the clerk would move to the next access point. Once all of the access points were covered, the clerk would return to the initial access point. This process continued until the shift was over. Repeat interviews of an angler on the same

tailwater were avoided to reduce bias that might be introduced by an extremely avid angler (Pollock et al. 1994).

Beginning in June 2001, the number of anglers unwilling to participate in the survey was tracked in order to account for non-response bias. The number of anglers approached by the clerk and the number of anglers that agreed to be surveyed were recorded for each sampling day. Anglers that said they had been interviewed previously or were targeting species other than trout were not included in this analysis. Dividing the number of interviews by the number of anglers approached resulted in a daily response rate. A mean response rate for the tailwater was obtained by averaging the response rates across all sampling days. Response data for the South Fork of the Holston River were not available.

Travel Cost Method

Questions 1 through 7 from the on-site survey provided the necessary information to estimate net value using the travel cost method. A zonal TCM approach as described by Pollock et al. (1994) was used with counties as distance zones. Because the TCM is not well suited to deal with multipurpose trips, only those anglers whose primary purpose for visiting the river was angling were included in travel cost analysis (Smith and Kopp 1980). The mean roundtrip travel distance of all anglers from a particular county was utilized as the zonal travel distance for that county. Potential outliers were eliminated by removing counties with zonal distances greater than 95% of the visitation zones (Pollock et al. 1994). Counties represented by only one angler within the sample were also eliminated.

The proportion of anglers from each county encountered during the current survey was multiplied by an estimate of the total number of angling trips taken to the site. Because this study did not estimate angling effort, recent creel survey reports were used to provide the number of angling trips. Since 1994, the Tennessee Cooperative Fishery Research Unit has performed creel surveys on these eight tailwaters at least once every four years. Therefore, the most recent creel data available for each tailwater were used to determine the total number of trips taken to each site. To allow for comparison of net value estimates among the study sites, effort estimates from comparable 26-week periods were used. Per capita visitation rate was estimated by dividing the total number of angling trips originating from each county by the population of that county.

Regressing the natural log of the per capita visitation rate against roundtrip travel distance created the first stage demand curve. This regression equation was then used to estimate visitation at increasing distances. The number of trips originating from each county was estimated at various distance increments until the number of trips equaled zero. Estimated visits were then summed across all distance zones. The first point represents total expected visitation at zero additional miles.

Prior to calculating consumer surplus, additional miles traveled were converted to additional cost. The total cost of travel consists of two parts, the vehicle cost and time cost of travel. The vehicle cost was calculated by multiplying the additional roundtrip distance by a mileage rate of $0.345/mile (U.S. Department of Revenue 2001) and then dividing by the mean party size in order to obtain a per angler estimate. Estimating the time cost of travel involved several steps. The first step was to average the midpoints of

angler income as obtained from the on-site survey. The average income was then divided by 2,080 (40 h per week X 52 weeks) to obtain an hourly wage rate. The following equation was then used to calculate the time cost of travel:

$$\text{Time Cost of Travel} = (DT)(WR)(0.25)/(50\text{mph})$$

where

DT = distance traveled (in mi)
WR = average wage rate.

Various researchers have used different percentages of the wage rate to calculate the time cost of travel. Cesario (1976) suggested that the value of travel time for adults ranges between 25% and 50% of the wage rate. Weithman and Haas (1982) and Menz and Wilton (1983) used 35% of the wage rate while Sorg et al. (1985) used one-third of the wage rate. Twenty-five percent of the wage rate was used in this study to allow for a conservative estimate of net value.

Having converted added miles to added cost, a regression line was fitted to the points of the second-stage demand curve. This equation was then integrated from zero to the maximum number of trips to estimate the total consumer surplus for the tailwater. Dividing the total net value by the total number trips and the mean trip length (in days) results in a per angler per day estimate of consumer surplus.

The on-site survey provided for incomplete trips and total trip expenditures had to be estimated by the anglers. Although this had the potential of biasing consumer surplus estimates, it was less likely where most anglers traveled relatively short distances and their primary purpose for the trip was fishing at that site (Pollock et al. 1994).

Contingent Valuation Method

A dichotomous CVM was used to determine the net value of trout fishing opportunities under current conditions and each of three management scenarios. These scenarios included the increased chance of catching twice the number of trout, the increased chance of catching a large trout (>406 mm), and a scenario in which the angler did not have to stop or cancel a trip due to high or unpredictable flows. Questions 13 through 16 on the survey form were used to obtain the necessary responses for contingent valuation. During the on-site survey, anglers were presented with each of the four CVM questions and asked if he or she would still have been willing to make the trip if their cost to make the trip had been a given amount more. Travel cost was used as the payment vehicle to avoid any negative bias that might be associated with payment vehicles such as taxes or user fees. An initial range of bids for the dichotomous choice questions was determined during a pretest of the on-site survey. Bid values ranged from $1 to $600 and were assigned to the questions following the technique used by Dalton et al. (1998). The first four bid amounts were assigned to the CVM questions on the first survey. Each CVM question on the second survey received the next higher bid amount than it received on the previous survey. When the highest bid amount was assigned to a CVM question, the lowest bid amount was entered for that question on the following survey. This process was repeated until all CVM questions on all surveys had received a bid amount.

Logistic regression was used to model the probability of a "yes" response as a function of explanatory variables. The variables used in this analysis included the bid amount offered, trip related expenditures, miles driven, trip length, angler income, and other demographic characteristics. According to economic theory, these factors should exhibit significant influence on an individual's willingness to pay. Prior to performing regression analysis, potential outliers were eliminated by removing observations in which an angler accepted or rejected a bid amount that was rejected or accepted by 95% of the other respondents, respectively. An iterative procedure was used to develop models explaining the greatest amount of variation in responses with the fewest number of significant variables. The final step in producing the models was to check for goodness-of-fit using the Hosmer and Lemeshow test statistic (SAS Institute, Inc. 1995). If the null hypothesis that the model provided a good fit to the data was rejected ($P < 0.05$), independent variables were transformed and the analysis was repeated. Determining the area under the curve produced by the final model provided an estimate of the mean willingness to pay by anglers for each scenario. This value was obtained by integrating the logistic regression equation for each scenario in each river.

RESULTS

Trip and Angler Characteristics

Caney Fork River. Most (95%) of the trout anglers interviewed on the Caney Fork River during 2001 were Tennessee residents (Table 1). Residents traveled from 32 Tennessee counties to fish for trout in the Caney Fork River. Anglers from the counties surrounding the Caney Fork River (DeKalb, Putnam, and Smith) made up only 21% of the resident portion of the sample. The majority (57%) of trout anglers came from counties in the Nashville metropolitan area (Davidson, Rutherford, Williamson, and Wilson). This was the same proportion observed by Devlin and Bettoli (1999). Non-resident anglers traveled from 13 different states with over 45% originating from Alabama, Indiana, Kentucky, and Ohio.

The Caney Fork River had the second highest percentage (7%) of anglers who reported that trout fishing was not the primary purpose of the trip. Many of these anglers said that they had primarily traveled to the area to camp at the U.S Army Corps of Engineers campground located near the dam and to fish Center Hill Reservoir.

The mean party size was 1.9 anglers (SD = 1.0) and these individuals spent an average of 1.4 d (SD = 1.3) on their fishing trip. Anglers on the Caney Fork caught an average of 1.6 trout per h (SD = 2.9) and most (67%) reported having caught at least one trout at the time of the interview.

Mean roundtrip mileage for all visitors to the Caney Fork River was 136 mi (SD = 167). These anglers spent an average of $64.98 per trip. When comparing resident versus non-resident anglers, the non-resident anglers traveled a greater distance (mean = 796 mi, SD = 491) than did resident anglers (mean = 111 mi, SD = 59). Total trip expenditures were also higher for the non-resident anglers (Mean = $486.81, SD = $185.51) than for resident visitors (Mean = $66.71, SD = $93.39).

The average age of trout anglers on the Caney Fork River was 42.4 years (SD = 13.3) with ages ranging from 15 to 82 years (Table 2). Almost all (97%) of the anglers were men. Anglers on the Caney Fork River were well educated. Forty percent of the anglers earned a four-year college degree and 17% completed some college; only 10% had not earned a high school diploma. The modal annual household income for anglers was $40,000 to $60,000. Many (45%) of the anglers had an annual household income greater than $60,000 and only 8% earned less than $20,000 annually.

As was observed at all the tailwaters studied, anglers at the Caney Fork River used bait (48%) more than artificial lures (10%) or flies (31%). The bait designation included both natural bait (worms, corn, and salmon eggs) and artificial bait (e.g. PowerBait®). Only 11% of the anglers used two or more fishing methods on the same trip. The majority (52%) of Caney Fork anglers were wading. Shore fishermen accounted for 40% of all anglers encountered and 5% of the anglers interviewed fished from boats.

Clinch River. Nearly 600 trout anglers were interviewed on the Clinch River (Table 1). Nearly all (97%) of these anglers were residents of Tennessee. Of the resident anglers, 80% were from the three counties adjacent to the Clinch River (Anderson, Campbell, and Knox). These three counties also represented 78% of the entire sample. Knox County alone accounted for over 50% of all anglers surveyed. These results are similar to those reported by Bettoli and Bohm (1997). Most (75%) of the non-resident trout anglers were from Florida, Kentucky, North Carolina, and Ohio. Only 4% of the anglers indicated that fishing for trout was not the primary purpose for their trip to the Clinch River.

The mean party size was 1.7 anglers (SD = 0.9) and these individuals spent an average of 1.3 d (SD = 3.8) on their fishing trip. Anglers on the Clinch River caught an average of 1.4 trout per h (SD = 2.2) and the majority (58%) reported having caught at least one trout at the time of the interview.

Mean roundtrip mileage for all visitors to the Clinch River was 75 miles (SD = 161) and these anglers spent an average of $40.03 per trip. When comparing resident versus non-resident anglers, the non-resident anglers traveled a greater distance (mean = 707 mi, SD = 542) than did resident anglers (mean = 54 mi, SD = 58). Total trip expenditures were also higher for the non-resident anglers (mean = $371.76, SD = $230.39) than for resident visitors (mean = $37.07, SD = $64.87).

The average age of trout anglers on the Clinch River was 43.9 years (SD = 15.2) with ages ranging from 14 to 81 years (Table 2). Almost all (97%) of the anglers were men. Anglers on the Clinch River were also well educated. Thirty percent of the anglers earned a four-year college degree and 20% completed some college; only 12% had not earned a high school diploma. The modal annual household income for visitors to the Clinch River was $20,000 to $40,000, although many (59%) of the anglers had an annual household income greater than $40,000. Anglers earning less than $20,000 a year accounted for 15% of the total sample.

Most (56%) of anglers on the Clinch River used bait, followed by flies (21%), a combination of two or more methods (15%), and lures (9%). A greater percentage of anglers fished from boats on the Clinch River (9%) than on any other tailwaters.

Duck River. Only 126 trout anglers were interviewed on the Duck River during the 2001 survey period. This was the fewest interviews obtained at any of the eight

tailwaters. This low sample size can be attributed to several factors. The Duck River receives low fishing pressure relative to the other tailwaters; only the Elk River received less fishing pressure than the Duck River (Bettoli 2001a). A large proportion of anglers indicated that they were not targeting trout; therefore, they were not interviewed. Bettoli (2001) found that 37% of the anglers interviewed during a previous creel survey were fishing primarily for warmwater species. Anglers in the present study that indicated they were targeting species other than trout were not interviewed. Eighty-four percent of the anglers contacted agreed to participate in the survey, which was the lowest response rate encountered in this study.

Of the 126 anglers surveyed, almost all (98%) were Tennessee residents (Table 1). The resident portion of the sample was represented by 13 Tennessee counties. Most (50%) of the resident anglers came from Bedford and Coffee Counties alone. Three counties in the Nashville metropolitan area (Davidson, Rutherford, and Williamson) accounted for 28% of the resident anglers. Almost all (98%) of the anglers interviewed indicated that they had traveled to the Duck River to fish for trout.

The mean party size was 1.4 anglers (SD = 0.6) and these individuals spent an average of 1.1 d (SD = 0.7) on their fishing trip. Anglers on the Duck River caught an average of 1.2 trout per h (SD = 2.1). Only 38% of those surveyed reported having caught at least one trout at the time of the interview.

Mean roundtrip mileage for all visitors to the Duck River was 69 mi (SD = 99). These anglers spent an average of $41.03 per trip. Non-resident anglers traveled a greater distance (mean = 538 mi, SD = 359) than did resident anglers (mean = 58 mi, SD = 49). Total trip expenditures were also higher for non-resident anglers (mean = $545.11, SD = $644.82) than resident visitors (mean = $32.58, SD = $27.10).

The average age of trout anglers on the Duck River was 44.3 years (SD = 16.0) with ages ranging from 17 to 83 years (Table 2). Almost all (96%) of the anglers were men. The number of anglers having earned a four-year college degree accounted for 38% of all anglers and an additional 13% had completed some college. Only 17% had not earned a high school diploma. The modal annual household income for visitors to the Duck River was $20,000 to $40,000 and 23% of the anglers had an annual household less than $20,000.

The Duck River had one of the highest percentages (23%) of trout anglers using flies; that rate was also 23% in the Elk River. Forty-eight percent of the anglers used bait. Most (68%) of the trout anglers encountered on the Duck River were fishing from shore. No trout anglers were observed fishing from boats during the survey.

Elk River. During the survey period, 153 trout anglers were interviewed on the Elk River, the second lowest number of interviews. The small sample size was probably a result of the low fishing pressure the Elk River receives. Bettoli (2001b) estimated the fishing pressure on the Elk River to be around 261 h per week. In comparison, the fishing pressure at popular Tennessee trout fisheries such as the South Fork of the Holston River can exceed 4,000 h per week in some instances (Bettoli et al. 1999).

Of the 153 trout anglers interviewed, 84% were residents traveling from 22 Tennessee counties (Table 1). Anglers from the three counties surrounding the Elk River (Franklin, Lincoln, and Moore) made up 48% of the resident sample. Counties of the Nashville metropolitan area (Davidson, Rutherford, and Williamson) constituted 20% of the resident anglers. Most (88%) of the non-resident anglers were from Alabama and

these anglers were 14% of all anglers encountered. Other states represented were Georgia, Iowa, and Oklahoma with each constituting 4% of the non-resident sample. Only 5% of the anglers traveled to the Elk River for reasons other than trout fishing.

The mean party size was 1.6 anglers (SD = 0.8) and these individuals spent an average of 1.2 d (SD = 0.7) on their fishing trip. Anglers on the Elk River caught an average of 2.3 trout per h (SD = 3.7) and only 29% said they had not caught any trout prior to being interviewed. The catch rate on the Elk River was one of the highest observed in this study; the Obey River also had a catch rate of 2.3 trout per h. High catch rates on the Elk River were also observed by Bettoli (2001) and Bettoli and Besler (1996).

Mean roundtrip mileage for all visitors to the Elk River was 133 mi (SD = 359). These anglers spent an average of $54.45 per trip. The non-resident anglers traveled a greater distance (mean = 395 mi, SD = 844) than did resident anglers (mean = 83 mi, SD = 71). Total trip expenditures were also higher for non-resident anglers (mean = $158.43, SD = $344.11) than for resident visitors (mean = $43.87, SD = $49.45).

The average age of trout anglers on the Elk River was 43.2 years (SD = 15.0) with ages ranging from 13 to 80 years (Table 2). Almost all (98%) of the anglers were men. Anglers on the Elk River were well educated, with 42% of the anglers having earned a four-year college degree and 13% having completed some college. Only 13% had not earned a high school diploma. The modal annual household income for visitors to the Elk River was over $100,000.

The Elk River fishery had the highest percentage (32%) of fly fishermen and the lowest percentage (38%) of bait anglers of the eight tailwaters. This fishery also had one of the highest percentages (23%) of anglers using artificial lures. The majority (58%) of trout anglers on the Elk River were wading. No other tailwater had a greater percentage of wade anglers. Shore anglers made up 38% of the total sample, which was the lowest percentage observed. Only 3% of the Elk River trout anglers fished from a boat.

Hiwassee River. Over 320 trout anglers were interviewed on the Hiwassee River. Of these, 85% were Tennessee residents (Table 1). Residents traveled from 17 Tennessee counties to fish for trout. Almost all (88%) of the resident anglers lived in Bradley, Hamilton, McMinn, and Polk Counties. Bradley County alone accounted for 38% of the resident sample. Anglers from Georgia and Alabama made up 65% and 12% of all non-residents, respectively. Other states represented in the sample were Florida, Indiana, North Carolina, New York, Ohio, Oklahoma, South Carolina, and Texas. Only 3% of the anglers indicated that they made the trip to the Hiwassee River for purposes other than trout fishing.

The mean party size was 1.8 anglers (SD = 1.0) and these individuals spent an average of 1.3 d (SD = 0.7) on their fishing trip. Anglers on the Hiwassee River caught an average of 1.4 trout per h (SD = 2.0) and 32% had not caught any trout at the time of the interview.

Mean roundtrip mileage for all visitors to the Hiwassee River was 141 mi (SD = 285). These anglers spent an average of $90.71 per trip). Non-resident anglers traveled a greater distance (mean = 493 mi, SD = 605) than did resident anglers (mean = 78 mi, SD = 73). Total trip expenditures were also higher for non-resident anglers (mean = $370.47, SD = $442.81) than for resident visitors (mean = $60.76, SD = $94.64).

The average age of trout anglers on the Hiwassee River was 43.1 years (SD = 12.7) with ages ranging from 16 to 77 years (Table 2). Almost all (96%) of the anglers were men. Only 26% of the anglers on the Hiwassee River had earned a four-year college degree, although an additional 15% had completed some college. The modal annual household income for anglers was $40,000 to $60,000. Many (35%) anglers had an annual household income greater than $60,000 and only 4% earned less than $20,000 annually.

Bait anglers accounted for 61% of the interviews on the Hiwassee River. This was the same percentage of anglers that were observed fishing from shore. Artificial lures and flies were used by 10% and 19% of the trout anglers, respectively. Wading anglers made up 32% of the total sample, while only 1% of the anglers fished from boats.

Obey River. Over 320 trout anglers were interviewed on the Obey River during the study period. Of these, 79% were Tennessee residents (Table 1). Residents traveled from 41 Tennessee counties to fish for trout on the Obey River. The highest percentage (14%) of resident anglers lived in Sumner County, followed by Clay County (9%), Putnam County (9%), Davidson County (8%), and Overton County (8%). All other counties made up 6% or less of the total resident sample. A greater proportion of non-resident anglers fished the Obey River (21%) than any other river. Individuals from Indiana, Kentucky, and Ohio represented 64% of the non-resident anglers. Other states represented in the survey were Alabama, Florida, Georgia, Illinois, Michigan, North Carolina, Oklahoma, Virginia, Washington, and West Virginia. About 20% of the anglers interviewed on the Obey River had traveled to the area for purposes other than trout fishing. This was the greatest percentage of multipurpose trips observed on any of the tailwaters. Many anglers were camping at the USACE campground located just downstream from the dam and had made the trip primarily for that purpose. Others came to fish Dale Hollow Reservoir.

The mean party size was 2.2 anglers (SD = 1.1) and these individuals spent an average of 3.0 d (SD = 3.0) on their fishing trip. Anglers on the Obey River caught an average of 2.3 trout per h (SD = 3.8), although 34% reported not catching any trout prior to being interviewed.

Mean roundtrip mileage for all visitors to the Obey River was 251 mi (SD = 351). These anglers spent an average of $149.15 per trip. The non-resident anglers traveled a greater distance (mean = 621 miles, SD = 643) than resident anglers (mean = 164 mi, SD = 132). Total trip expenditures were also higher for non-resident anglers (mean = $390.92, SD = $269.59) than for resident anglers (mean = $134.69, SD = $157.07).

The average age of trout anglers on the Obey River was 50.5 years (SD = 15.3) with ages ranging from 15 to 88 years (Table 2). This was the greatest mean age at any of the eight tailwaters. Women accounted for 8% of anglers on the Obey River. Many (38%) of the anglers had earned a high school diploma. Only 21% of the anglers on the Obey River had earned a four-year college degree and another 18% completed some college. Sixty-two percent did not have a high school diploma. The modal annual household income for visitors to the Obey River was $40,000 to $60,000, although many (40%) of the anglers had an annual household income less than $40,000.

Nearly all (90%) of the anglers on the Obey River were fishing from the riverbank or public access piers. Boat anglers accounted for just 1% of the total sample and only slightly more (8%) were wading. Most (73%) of the anglers were using bait. This

percentage of bait use was the highest observed among all eight tailwaters. Only 10% of the anglers used artificial lures and even fewer (7%) used flies, which was the lowest percentage of fly fishermen among the eight rivers.

South Fork of the Holston River. Three hundred and fifty-nine anglers were interviewed on the South Fork of the Holston River. Tennessee residents made up 79% of the entire sample (Table 1). Resident anglers traveled from 13 Tennessee counties to fish for trout. Most (94%) resident anglers lived in the three counties adjacent to the river (Carter, Sullivan, and Washington Counties). Bettoli et al. (1999) also found that 94% of the anglers in their creel survey lived in these three counties. Virginia anglers accounted for 75% of non-residents and 16% of all anglers surveyed. Of the remaining non-residents, only anglers from North Carolina were common (17% of non-residents). Nearly all (97%) of the anglers interviewed had traveled to the South Fork of the Holston River to fish for trout.

The mean party size was 1.7 anglers (SD = 0.8) and these individuals spent an average of 1.1 d (SD = 0.8) on their fishing trip. Anglers on the south Fork of the Holston River caught an average of 1.5 trout per h (SD = 2.6) and the majority (63%) had caught at least one trout at the time of the interview.

Mean roundtrip mileage for all visitors to the South Fork of the Holston River was 73 mi (SD = 221). These anglers spent an average of $28.71 per trip. When comparing resident versus non-resident anglers, non-resident anglers traveled a greater distance (mean = 215 mi, SD = 443) than resident anglers (mean = 36 mi, SD = 56). Total trip expenditures were also higher for the non-resident anglers (mean = $103.81, SD = $196.78) than for resident visitors (mean = $18.65, SD = $24.86).

The average age of trout anglers on the South Fork of the Holston River was 41.5 years (SD = 15.5) with ages ranging from 13 to 81 years (Table 2). Almost all (96%) of the anglers were men. The South Fork of the Holston River fishery had the lowest percentage (17%) of anglers with a four-year college degree. This tailwater also had the highest percentage (23%) of anglers that had not completed high school. The modal annual household income for visitors to the South Fork of the Holston River was $20,000 to $40,000. The number of anglers earning less than $20,000 annually accounted for 19% of the total sample. Only 14% of the anglers had an annual household income of more than $60,000.

Bait anglers accounted for 61% of the interviews on the South Fork of the Holston River, followed by fly fishermen (22%) and anglers using artificial lures (12%). Most (76%) of the trout anglers were fishing from shore. Wading anglers made up 21% of the sample, and only 1% of the anglers were fishing from boats.

Watauga River. During the 12-month study period, 304 anglers were interviewed on the Watauga River. Most (87%) of the anglers were residents of Tennessee (Table 1). Resident anglers traveled from 15 Tennessee counties to fish for trout. Most (92%) of the resident anglers lived in Carter, Sullivan, and Washington counties. No other county contributed over 2% to the resident sample. Non-resident anglers lived in 7 other states and the District of Columbia. Anglers from North Carolina and South Carolina represented nearly 70% of all non-residents. Other states represented in the sample included Florida, Georgia, Illinois, Indiana, and Virginia. Only 2% of all anglers indicated that they had traveled to the Watauga River for purposes other than trout fishing.

The mean party size was 1.8 anglers (SD = 0.8) and these individuals spent an average of 1.1 d (SD = 0.5) on their fishing trip. Anglers on the Watauga River caught an average of 1.3 trout per h (SD = 2.0), although 47% had not caught any trout prior to being interviewed.

Mean roundtrip mileage for all visitors to the Watauga River was 66 mi (SD = 154). These anglers spent an average of $38.13 per trip. When comparing resident versus non-resident anglers, the non-resident anglers traveled a greater distance (mean = 316 mi, SD = 329) than did resident anglers (mean = 36 mi, SD = 73). Total trip expenditures were also higher for the non-resident anglers (Mean = $200.86, SD = $195.97) than for resident visitors (Mean = $22.94, SD = $58.17).

The average age of trout anglers on the Watauga River was 42.3 years (SD = 14.3) with ages ranging from 16 to 85 years (Table 2). Almost all (96%) of the anglers were men. Only 22% of the anglers on the Watauga River had earned a four-year college degree, although an additional 20% had completed some college. Twenty-one percent of anglers had not finished high school. The modal annual household income for visitors to the Watauga River was $20,000 to $40,000. This fishery had the greatest percentage (26%) of anglers earning less than $20,000.

Angling methods used on the Watauga River were very similar to those observed on the nearby South Fork of the Holston. Bait anglers accounted for 60% of the interviews on the Watauga River, followed by flies (19%) and artificial lures (12%). Most (74%) of the trout anglers were fishing from shore. Wading anglers made up 22% of the sample and 1% of the anglers were fishing from boats.

Travel Cost Method

Caney Fork River. In general, per capita visitation rate decreased with increased distance from the Caney Fork River. This relationship is expected and was observed on all of the rivers. The highest per capita visitation rates were from nearby counties, DeKalb and Putnam (Table 3). Most of the trips to the Caney Fork were made by anglers from the metropolitan Nashville area (Davidson and Rutherford Counties). Some anglers traveled as far as 270 miles roundtrip, but did so at a much lower rate.

Predicted trips to the Caney Fork River at zero additional miles were 16,426 trips (Table 4). At 800 additional miles, predicted trips dropped to zero. The total cost of travel for anglers on the Caney Fork was $0.32 for each additional mile (Table 5). The consumer surplus estimate for the Caney Fork River was highest of all eight rivers at $485,875 (Figure 2). When net value is added to angler expenditures, the result is a total economic value of $1,782,356, which was also the highest among all rivers (Table 6).

Clinch River. Per capita visitation to the Clinch River was greatest for Anderson, Union, and Knox Counties (Table 3). Knox County had the highest number of estimated trips. Zone visitation rates declined substantially when anglers had to travel more than 40 miles (one-way). Anglers were predicted to take 19,209 trips at zero additional miles, but no trips were made when anglers had to travel an additional 350 miles (Table 7). Anglers incurred a cost of $0.32 for each additional mile they had to drive (Table 5). Total net benefit derived from the Clinch River fishery was $238,851 (Figure 3). Angler expenditures totaled $986,139 resulting in a total economic value of $1,224,990 (Table 6).

Duck River. Anglers traveling less than thirty miles roundtrip (Bedford, Coffee, Moore Counties) visited the Duck River at the highest rates (Table 3). Despite its dense population, Davidson County had the lowest per capita visitation rate to the Duck River. This can be attributed to the greater distance (150 mi roundtrip) those anglers had to travel.

Predicted visitation to the Duck River was 7,938 trips when anglers did not have to travel any additional distance (Table 8). When additional mileage increased to 300 miles, the number of predicted trips declined to zero. Each added mile cost an angler approximately $0.36 (Table 5). Trout anglers fishing the Duck River received $101,321 in net benefit (Figure 4). These anglers spent a total of $369,639 during their visits for a total economic value of $470,960 (Table 6)**.**

Elk River. Counties over 50 miles away from the Elk River had the lowest per capita visitation rates. The greatest rates of visitation were from counties approximately 10 to 20 miles away (Franklin, Lincoln, and Moore Counties) (Table 13). As was observed on the Duck River, anglers from the Nashville metropolitan area (Davidson County) traveled to the Elk River at a lower rate than other zones.

At zero additional mileage total estimated visitation was to the Elk River was 1,936 trips (Table 9). As additional mileage increased to 350 miles, estimated visitation declined to zero. For each additional mile that anglers had to travel, they incurred a cost of $0.36 (Table 5). Estimated net value for the Elk River fishery was $34,639, the lowest of all eight rivers (Figure 5). Although Elk River anglers spent the fourth highest amount per trip, the low number of trips taken to this river resulted in angler expenditures of only $148,213 (Table 6). The total economic value of the Elk River trout fishery was $182,852.

Hiwassee River. The majority of angling trips to the Hiwassee River were taken by anglers traveling 80 miles or less (Table 3). Per capita visitation rates were substantially lower for zones farther than 30 miles away. Marion County had a relatively high visitation rate despite its small population and the great distance (168 mi) that the anglers from this county had to travel. Gwinnett and Fulton Counties in Georgia had the lowest per capita visitation rates. Over 11,000 trips to the Hiwassee River were predicted when anglers did not have to travel any further (Table 10). As additional distance increased to 450 miles, total visitation dropped to zero. Anglers had to pay an additional $0.33 for each added mile traveled (Table 5). Net value was estimated at $200,789 (Figure 6) and anglers spent $1,513,043 (Figure 5). This equated to a total economic value of $1,713,832 (Table 6).

Obey River. The highest visitation rates to the Obey River were from nearby counties (Clay, Overton, Jackson, and Pickett) (Table 3). Anglers from these counties traveled 60 miles or less to fish for trout on the Obey River. Visitation declined substantially as additional roundtrip mileage exceeded 200 miles. The lowest visitation rates were observed for Davidson, Washington, Montgomery, Rutherford, and Knox Counties.

When there were no additional miles per trip, predicted visitation to the Obey River was 10,717 trips (Table 11). Total predicted trips did not decline to zero until additional miles traveled reached 1,000. Each additional mile driven to the Obey River cost anglers $0.28/mi (Table 5). Net value for the Obey River was estimated at $365,083

and angler expenditures totaled $1,290,148 (Table 6, Figure 7). These values represented a total economic value of $1,655,231.

South Fork of the Holston River. Nearly all (95%)of the estimated trips taken to the South Fork of the Holston were from zones less than 30 miles (one-way) from the river (Table 3). The highest per capita visitation rates were from Carter, Sullivan, and Washington Counties in Tennessee and Washington County, Virginia. Anglers traveling from Virginia and North Carolina typically visited the South Fork of the Holston River at lower rates.

Anglers took over 9,000 predicted trips when the additional miles equaled zero (Table 12). As travel distance increased to 750 miles, estimated visitation dropped to zero. Travel cost for each additional mile was $0.30 (Table 5). Determining the area under the second-stage demand curve resulted in a net value estimate of $235,537 (Figure 8). Adding this to total expenditures ($695,988) yielded a total economic value of $931,525 (Table 6).

Watauga River. Estimated visitation patterns for the Watauga River were similar to those observed for the South Fork of the Holston River with most (92%) of the trips originating less than 20 miles (one-way) from the fishery (Table 3). Considering the close proximity of these two rivers, it is not surprising that visitation was highest from the same counties (Carter, Sullivan, and Washington). Anglers from North Carolina and South Carolina traveled as much as 150 miles (one-way) to fish the Watauga River, but visited the river at much lower rates than resident anglers.

Predicted visitation to the Watauga River was 8,000 trips at zero additional mileage, but dropped to zero as added distance increased to 700 miles (Table 13). Travel cost was found to increase by $0.28 for each additional mile driven (Table 5). Net value for the Watauga River was estimated at $193,539 (Figure 9). Angler expenditures for the Watauga River totaled $642,834 and total economic value was $836,373 (Table 6).

Contingent Valuation Method

Caney Fork. Predictive models were generated for all four angling scenarios on the Caney Fork River (Table 14). The natural log of the bid offered to the angler was significant in three of the four scenarios. However, the untransformed bid amount was used for the large trout scenario in order to improve the fit of the model. Other significant variables included angler income in the models for current conditions and flows, total trip expenditures for the increased chance of catching more trout, and trip length (in days) for the chance to catch a large trout. Adjusted R-squared values ranged from 0.47 on the “more trout” and “large trout” scenarios to 0.35 for not having to cancel a trip due to high or unpredictable flows.

The CVM estimate of net value for current trout fishing conditions at the Caney Fork River was $64.31/d (Table 15). Consumer surplus increased under improved fishing conditions with estimates of $91.09/d and $93.31/d for the more trout and large trout scenarios, respectively. However, the average net value for not having to cancel trips due to high flows was only $51.50 per day, or a 20% decrease in consumer surplus (Table 16). Anglers on the Caney Fork River valued the opportunity of catching a large trout (>456 mm) about the same as the chance of catching more trout. There was a 45%

increase in net value over current conditions with the "large trout" scenario, whereas the resulting increase for the "more trout" scenario was 42%.

Clinch River. The natural log of the bid amount offered to the angler was significant in all four of the logistic regression models for the Clinch River (Table 14). Angler income was significant in all models except for the flows scenario. Adjusted R-squared values ranged from 0.34 for the large trout model to 0.42 for current conditions.

Anglers on the Clinch River received $54.43 per day in benefit above their trip expenditures for present angling conditions (Table 15). This benefit increased with the enhancement of angling opportunities. Net value was estimated at $84.58 per day for the chance to catch more trout and $117.30 per day for the opportunity to catch a large trout. Unlike most of the other tailwaters, there was an increase (12%) in consumer surplus over current conditions for not having to cancel a trip due to high flows (Table16). The chance of catching more trout resulted in a 55% increase in net value, whereas the "large trout" scenario increased it by 116%. Thus, trout anglers on the Clinch River valued the quality of trout they caught over the quantity.

Duck River. Total trip expenditures and the natural log of the bid amount were used to create the three models for the Duck River (Table 14). The model for the "more trout" scenario explained 54% of the variation in anglers' willingness to pay and the "large trout" model explained 49% of the variation.

The net value estimates for the Duck River were the lowest of all of the rivers. Consumer surplus estimates for the "more trout" and "large trout" scenarios on the Duck River were $47.57/d and 62.10/d, respectively (Table 15). Both of these values were an increase over the $42.27/d estimate for present conditions. No estimate was made for the flows scenario because this fishery is not subject to drastic changes in flow from hydroelectric power generation. Net value increased by 13% under the "more trout" scenario and by 45% for the increased chance of catching a large trout (Table 16).

Elk River. The natural log of the bid amount offered was significant in all four models for the Elk River (Table 14). Angler income was significant in three of the four models. Adjusted R-squared values ranged from 0.24 on the flows model to 0.42 for the "more trout" scenario.

The Elk River had the third highest net value under current conditions at $61.14 per d (Table 15). The opportunity to catch more trout increased the benefit received by anglers to $86.70 per d, or a 42% gain in net value (Table 16). However, a substantially greater improvement in benefit was realized with the opportunity to catch a trout larger than 456 mm. Net value under this scenario was estimated at $159.77 per day, a 161% increase from current conditions. This was the largest net value estimate and greatest improvement in benefit that was observed on any river. The scenario regarding predictable flows resulted in a 38% decrease in consumer surplus.

Hiwassee River. The untransformed bid amount was used in the large trout and predictable flow models for the Hiwassee River and $\log_e$ bid was used in the other two models (Table 14). Using different forms of the bid amount was primarily an issue of model fit. R-squared values ranged from 40% for not having to cancel a trip due to flows to 57% for the chance of catching more trout.

Trout anglers on the Hiwassee River valued current angling conditions at $55.27 per day (Table 15). Estimates for the "more trout" and "large trout" scenarios were similar ($68.02 /d and $67.79/d, respectively). The increase in net value over current

conditions was 23% for both scenarios (Table 16), indicating that anglers on the Hiwassee River valued catching more trout or larger trout about the same. The Hiwassee River was one of only two tailwaters where anglers received increased benefit from lower or more predictable flows; consumer surplus under this scenario was $58.49/d, a 6% improvement.

Obey River. The natural log of the bid amount was significant in all four angling scenarios for the Obey River and was the only significant predictor variable for the more trout scenario (Table 14). The amount of money that anglers spent on their trips was important in determining their responses to the CVM questions for current conditions and the "large trout" scenario. However, the number of miles an angler drove was a more important predictor variable in the predictable flows model. R-squared values ranged from 0.30 for the predictable flows scenario to 0.47 for current conditions.

The CVM estimate of net value for current trout fishing conditions on the Obey River was the second lowest of all rivers at $47.00/d (Table 15). The estimates for the "more trout" and "large trout" scenarios were $48.18/d and $50.18/d, respectively. Although both of these values were an increase over current conditions, the improvements were the smallest observed on any of the other rivers (3% and 7%) (Table 16). The consumer surplus estimate of $32.73/d for lower and more predictable flows represented a 30% decrease from current conditions.

South Fork of the Holston River. Angler income and the natural log of the bid amount were significant predictor variables in all four models for the South Fork of the Holston River (Table 14). The amount of variation in willingness to pay explained by the models ranged from 54% for the "more trout" scenario to 43% for not having to cancel a trip due to high or unpredictable flows.

Anglers were willing to pay $57.09/d for current conditions in the South Fork of the Holston River (Table 15). When presented with the increased chance of catching a large trout, net value improved to $64.87/d. The opportunity of catching more trout, however, was more important to anglers because the consumer surplus rose to $72.13/d. Consumer surplus for the predictable flows scenario ($36.97/d) was 35% lower than for current conditions, indicating that anglers did not value a change in the flow regime. The "more trout" and "large trout" scenarios, however, produced an increase in net value of 26% and 14%, respectively (Table 16).

Watauga River. As was the case for the South Fork of the Holston River, the natural log of the bid amount and angler income were significant predictor variables in all four angling scenarios (Table 14). Adjusted R-squared values range from 0.37 for current conditions to 0.44 for the chance of catching more trout.

Anglers on the Watauga River received greater benefit ($91.69/d) for current trout fishing conditions than did anglers on any other river (Table 15). Anglers were only willing to pay $46.09/d for a change to the flow regime. Net value estimates for the "more trout" and "large trout" scenarios were $116.00 and $109.12, respectively. Thus net benefit increased by 27% when anglers had the chance to catch more trout and by 19% when they were more likely to catch a large trout (Table 16). Consumer surplus decreased by 50% for predictable flows, which was the greatest decrease observed among the eight rivers for this scenario.

DISCUSSION

Angler Characteristics

With little exception, the anglers from the eight rivers were similar in terms of age and gender with the majority being men in their early forties. These anglers were alike in that most of them used bait and fished from shore. There was a relationship observed between an angler's income and their level of education. Rivers that had a higher percentage of anglers having at least a college degree also tended to exhibit a higher modal income.

The Elk, Hiwassee, Obey, South Fork of the Holston, and Watauga Rivers exhibited the highest percentages of non-resident anglers. Not surprisingly, most of these fisheries were near areas where Tennessee bordered other states. As was expected, those anglers that traveled the greatest distances tended to take longer trips and spent more money during that time.

Travel Cost Method

The net value of trout fishing opportunities, as measured by the travel cost method, differed among the eight Tennessee tailwaters studied. The TCM estimate of consumer surplus for the Caney Fork River was higher than any of the other rivers. This can be attributed to the large portion of trips made by anglers from the Nashville metropolitan area and the large distance they traveled.

The Obey River trout fishery had a higher net value than was expected when this survey began. This tailwater is not known for producing large numbers of quality fish and is managed primarily as a put-and-take fishery. However, anglers traveled on average nearly twice as far to the Obey River than to any other river. Many of these anglers were on extended camping trips at the USACE campground or said that they had fished Dale Hollow Reservoir. Although these anglers were asked if the primary purpose of their trip had been to fish for trout in the Obey River, it is not clear if they were able to separate trout fishing from other motives they may have had for visiting that river. Inclusion of anglers whose primary purpose was not trout fishing would result in an overestimate of consumer surplus based on the travel cost method.

Anglers on the Elk River received less net benefit from their fishing trips than did anglers on any other river. Because the TCM is based on angler visitation patterns, the low net value is due to the low number of trips taken to this river and the fact that most of the anglers were from counties close to the fishery. The Elk River had a relatively high percentage of non-resident anglers, but anglers traveling from Alabama did not have to travel far to fish that river. A similar visitation pattern was observed on the Duck River and was responsible for the relatively low consumer surplus estimate for that fishery, although anglers made more trips to the Duck River than the Elk River.

The net values for the Clinch, South Fork of the Holston, and Watauga fisheries were less than what was expected. These are quality fisheries that are highly regarded by anglers; therefore, estimates of consumer surplus were expected to be higher. However, these rivers had visitation characteristics similar to the Elk River and Duck River (i.e., the majority of angling trips originated from nearby counties). The South Fork of the

Holston River and the Watauga River had high percentages of non-resident anglers, but these anglers did not have to travel great distances because those fisheries are located near the state border.

The consumer surplus estimates derived in this study are low in comparison to other studies that used the travel cost method to estimate the value of trout fishing. Kerkvliet et al. (2002) reported that anglers valued the blue-ribbon trout fisheries in Yellowstone National Park between $172/d and $977/d. The total net value of the trout fishery in Lake Taneycomo, Missouri was estimated at $2.9 million (Weithman and Haas 1982). Nowell and Kerkvliet (2000) used an on-site cost model, a modification of the TCM, to estimate consumer surplus for the fishery on the Henry's Fork of the Snake River, one of the best trout rivers in North America. Anglers traveled great distances to fish that famous river and consumer surplus was estimated at $159/d, or 9X – 22X higher than TCM estimates for Tennessee tailwaters in this study.

Contingent Valuation Method

As was observed with consumer surplus estimates obtained from the travel cost method, anglers valued fishing opportunities on the eight rivers differently. Based on CVM estimates for current conditions, anglers on the Watauga River had a higher willingness to pay than anglers on any other river. This suggests that Watauga River anglers received greater net benefit from their trout angling experiences. Anglers on the Duck River received less net benefit than anglers on the other tailwaters, as indicated by their lower willingness to pay. The relative ranking of CVM values could aid managers in allocating resources among the eight trout fisheries (Table 17).

Changes in net value were predicted with improvement in fishing conditions under the various management scenarios. The degree to which consumer surplus would change and how these changes would differ among the eight rivers, however, was not known. The more trout and large trout scenarios both resulted in an increase in net value over current conditions for all tailwaters. Anglers on five of the eight rivers valued the opportunity to catch a large trout over the opportunity to catch more trout. The "more trout" scenario was valued about the same as the "large trout" scenario by anglers on the Hiwassee River. Only anglers on the South Fork of the Holston and Watauga Rivers indicated that they would be willing to pay more for the opportunity to catch more trout, perhaps because both of those rivers supported good numbers of quality-sized fish already. Consumer surplus estimates for the predictable flows scenario were lower than those for the other scenarios and were lower than current conditions for all but two rivers, the Clinch and the Hiwassee. The low willingness to pay values for this scenario may have been due to the way in which the question was worded. Anglers were asked if they would be willing to pay more if they would not have to stop or cancel a fishing trip due to high or unpredictable flows. Each evening the Tennessee Valley Authority posts the generation schedule for the following day and many anglers said that they used this schedule to plan their trips. Therefore, anglers would not be expected to pay more for the increased predictability of flows that they already find predictable. To estimate the value that anglers would place on low flows (increased wading opportunity), the question would have to be aimed at flow levels and not involve predictability. Hartwig (1998) found that anglers on the Smith River, Virginia, did not receive an increase in net benefit

for a more predictable flow regime that they already considered predictable. These same anglers, however, indicated they would be willing to pay more for a flow regime without the high flows that prevented them from fishing.

A number of other studies have used a dichotomous CVM to measure the value of trout fishing opportunities with similar results. Allen (1988) estimated the willingness to pay of Montana trout anglers at $90.74/trip for present conditions. Wyoming trout anglers valued the opportunity to catch more trout or a large trout at $101.41/d and $131.90/d, respectively (Dalton et al. 1998). Although these authors did not report the consumer surplus estimates for current conditions, they did indicate that these values represented a substantial increase in net value. Much lower CVM estimates were reported by Hartwig (1998) for the Smith River, Virginia where trout anglers were willing to pay between $9.12 and $14.13 per trip for current conditions. This study, however, used a payment card from which anglers chose the maximum amount they would be willing to pay for a given scenario. When offered a number of bid amounts, these anglers may have chosen lower bid amounts thinking that it was in their best interest to do so. This could result in lower net value estimates than if anglers had to either reject or accept a given bid amount offered to them.

Comparison of TCM and CVM Estimates

The estimates of net value obtained using contingent valuation were higher in all cases than those measured by the travel cost method (Table 17). The greatest difference in values was observed on the Watauga River where the CVM estimate was nine times greater than the TCM estimate. Values for the Obey River were the most similar, differing by approximately $33.00. The relative ranking of the rivers changed somewhat between the two methods, although the rivers that were valued the highest (Caney Fork), and lowest (Elk) remained the same. Sorg et al. (1985) used both the TCM and CVM to value fishing opportunities in Idaho and reported that CVM estimates generally exceeded those obtained from the TCM. Hartwig (1998), however, found the TCM estimates to be consistently larger than CVM estimates.

The higher estimates derived from the CVM were likely a result of anglers not responding to the questions as they would if they actually had to pay the bid amount they were presented (Pollock et al. 1994). Although the dichotomous choice model was used because it more closely resembles a market scenario, the hypothetical nature of the questions may have resulted in hypothetical responses. Another contributing factor to the difference in estimates is that the TCM values were intentionally made conservative by using one-fourth of the wage rate when calculating the time cost of travel.

Despite their differences, the figures obtained from both methods each have their own merit. CVM estimates are helpful in estimating the value anglers place on alternative management approaches or different flow scenarios. Dalton et al. (1998) found that anglers fishing Wyoming streams would receive greater net benefit from an increased chance of catching a large trout than they would from increased trout populations. In instances where the manager must decide how to allocate resources among the eight rivers, the TCM values are probably most appropriate because they are based on observed angler behavior. For this same reason, TCM values should be used in cost-benefit analysis.

Management Implications

Estimating the economic impact of trout fishing at each of the eight tailwaters was outside the scope of this study, but the per-trip expenditures data reported herein could be used, with appropriate multipliers, to estimate that impact (e.g., Schorr et al. 1995). The relative ranking of each tailwater in terms of net value and total value should provide managers with justification for changing their allocation of resources at various tailwaters. For instance, the Caney Fork River fishery had the highest net value and total value over the fishing season in the TCM analysis, and the second highest net value per trip in the CVM analysis. The TWRA is currently discussing options with the U.S. Army Corps of Engineers for improving water quality in the Caney Fork River, which has been identified as one factor limiting the trout fishery (Devlin and Bettoli 1999). The high economic value anglers place on the Caney Fork River fishery could justify any efforts to improve habitat, provide for minimum flow, improve water quality, and increase access at this popular fishery. Similarly, the high value anglers placed on catching bigger fish (as opposed to catching more fish) at some waters would serve to justify management activities aimed at improving the quality (i.e., fish size) of the fishing at those rivers. It should be noted that economic characteristics of each fishery are just one consideration for managers contemplating any change in management schemes. The attitudes and motivations of trout anglers are known to differ among tailwaters (Hutt and Bettoli 2003) and their input, as well as a consideration of biological data, are needed to properly design and execute a management plan for each river.

The estimates of consumer surplus and total value over 6-month fishing seasons reported herein reflected fishing pressure in the recent past. For obvious reasons, changes in fishing pressure at each tailwater will directly affect the value of each fishery. For instance, pressure increased 50% at the Watauga River between 1998 and 2002 (Bettoli 2003a), and decreased a similar amount at the South Fork of the Holston River (Bettoli 2003b). Neither of those changes in pressure was attributed to differences in weather or discharge patterns, but fishing pressure is known to vary elsewhere as a function of the amount of water discharged through the turbines. Shifts in pressure could also occur at other tailwaters if management activities are undertaken to improve access or promote fishing (or simply due to random fluctuations). Thus, creel surveys need to be performed on a regular basis to track shifts in fishing pressure and the number of trips made to each tailwater. Estimates of mean willingness to pay (from the CVM analysis) and the net value per trip (TCM analysis) will likely vary over time as well, but probably not as quickly or dramatically as fishing pressure.

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Table 1.- Visitation and trip characteristics for trout anglers interviewed at eight tailwaters in Tennessee from January 2001 to January 2002. Unless otherwise noted, mean values are reported.

	Tailwater							
Characteristic	Caney Fork	Clinch	Duck	Elk	Hiwassee	Obey	SF Holston	Watauga
Number Interviewed	401	582	126	153	321	324	359	304
Percent Non-Residents	5	3	2	16	15	21	21	13
Percent Multipurpose Trips	7	4	2	5	3	22	3	2
Party Size	1.9	1.7	1.4	1.6	1.8	2.2	1.7	1.8
Trip Length (days)	1.4	1.3	1.1	1.2	1.3	3	1.1	1.1
Catch Rate (trout/hour)	1.6	1.4	1.2	2.3	1.4	2.3	1.5	1.3
Miles Traveled (roundtrip)	136	75	69	133	141	251	73	66
Trip Expenditures ($/angler)	65	40	41	54	91	149	29	38

Table 2.- Characteristics of trout anglers interviewed at eight tailwaters in Tennessee from January 2001 to January 2002. Unless otherwise noted, mean values are reported.

	Tailwater							
Characteristic	Caney Fork	Clinch	Duck	Elk	Hiwassee	Obey	SF Holston	Watauga
Age	42	44	44	43	43	51	41	42
Percent Male	97	97	96	98	96	93	96	96
Percent Married	74	69	74	75	80	82	61	62
Percent with College Degree	40	30	38	42	26	21	17	22
Modal Income ($1000's/year)	40-60	20-40	20-40	>100	40-60	40-60	20-40	20-40
Years Trout Fishing	15	16	15	14	19	16	20	19

Table 3.-Distance zones and estimated per capita visitation rates for eight Tennessee rivers.

County	Miles Traveled (roundtrip)	Estimated Trips	2000 Population	Per Capita Visitation Rate
		Caney Fork River		
Montgomery	270	107	134,768	0.0008
Warren	70	107	38,276	0.0028
Maury	153	213	69,498	0.0031
Marion	189	107	27,776	0.0038
Cheatham	155	160	35,912	0.0045
Dickson	199	213	43,156	0.0049
Rhea	158	160	28,400	0.0056
Cumberland	109	320	46,802	0.0068
Macon	100	160	20,386	0.0079
Davidson	122	4535	569,891	0.0080
Sumner	116	1280	130,449	0.0098
Robertson	153	587	54,433	0.0108
White	61	267	23,102	0.0115
Rutherford	103	2241	182,023	0.0123
Williamson	143	2081	126,638	0.0164
Smith	20	320	17,712	0.0181
Jackson	64	213	10,984	0.0194
Trousdale	76	160	7,259	0.0220
Wilson	83	2187	88,809	0.0246
VanBuren	109	160	5,508	0.0291
Putnam	47	2187	62,315	0.0351
DeKalb	30	854	17,423	0.0490
		Clinch River		
Claiborne	80	88	29,862	0.0029
Morgan	80	88	19,757	0.0044
Sevier	95	395	71,170	0.0056
Grainger	100	132	20,659	0.0064
Jefferson	96	307	44,294	0.0069
Scott	100	176	21,127	0.0083

Table 3 (continued)

County	Miles Traveled (roundtrip)	Estimated Trips	2000 Population	Per Capita Visitation Rate
		Clinch River (continued)		
Blount	81	922	105,823	0.0087
Loudon	85	351	39,086	0.0090
Roane	84	571	51,910	0.0110
Campbell	32	1230	39,854	0.0309
Knox	48	13701	382,032	0.0359
Union	40	922	17,808	0.0518
Anderson	19	4699	71,330	0.0659
		Duck River		
Davidson	150	509	569,891	0.0009
Williamson	104	436	126,638	0.0034
Maury	115	291	69,498	0.0042
Marshall	100	145	26,767	0.0054
Rutherford	85	1526	182,023	0.0084
Franklin	52	581	39,270	0.0148
Moore	24	218	5,740	0.0380
Coffee	26	2761	48,014	0.0574
Bedford	25	2180	37,586	0.0580
		Elk River		
Davidson	178	150	569,891	0.0003
Maury	115	38	69,498	0.0005
Hamilton	172	188	307,896	0.0006
Rutherford	118	131	182,023	0.0007
Madison (AL)	128	263	276,700	0.0009
Marion	100	38	27,776	0.0014
Williamson	153	188	126,638	0.0015
Grundy	85	38	14,332	0.0026
Coffee	45	169	48,014	0.0035
Moore	20	56	5,740	0.0098

Table 3 (continued)

County	Miles Traveled (roundtrip)	Estimated Trips	2000 Population	Per Capita Visitation Rate
		Elk River (continued)		
Lincoln	45	338	31,340	0.0108
Franklin	21	732	39,270	0.0186
		Hiwassee River		
Fulton (GA)	260	107	816,006	0.0001
Gwinnett (GA)	270	107	588,448	0.0002
Knox	140	107	382,032	0.0003
Davidson	333	161	569,891	0.0003
Cobb (GA)	260	268	607,751	0.0004
Etowah (AL)	277	107	103,459	0.0010
Walker (GA)	140	107	61,053	0.0018
Whitfield (GA)	115	483	83,525	0.0058
Hamilton	106	2306	307,896	0.0075
Marion	168	215	27,776	0.0077
Meigs	80	161	11,086	0.0145
Monroe	58	644	38,961	0.0165
McMinn	44	2145	49,015	0.0438
Bradley	71	5471	87,965	0.0622
Polk	31	2735	16,050	0.1704
		Obey River		
Clay	11	793	7,976	0.0994
Overton	47	655	20,118	0.0325
Jackson	61	310	10,984	0.0282
Pickett	60	138	4,945	0.0279
Macon	84	310	20,386	0.0152
Putnam	75	724	62,315	0.0116
Cumberland	128	414	46,802	0.0088
Monroe (KY)	27	103	11,756	0.0088
Sumner	156	827	130,449	0.0063
Sequatchie	250	69	11,370	0.0061

Table 3 (continued)

County	Miles Traveled (roundtrip)	Estimated Trips	2000 Population	Per Capita Visitation Rate
		Obey River (continued)		
Haywood	460	103	19,797	0.0052
White	103	103	23,102	0.0045
Robertson	202	207	54,433	0.0038
Rhea	197	103	28,400	0.0036
Roane	194	172	51,910	0.0033
Marion	245	69	27,776	0.0025
Wilson	177	207	88,809	0.0023
Cheatham	270	69	35,912	0.0019
Williamson	231	172	126,638	0.0014
Hamilton	310	379	307,896	0.0012
Boone (KY)	323	103	85,991	0.0012
Hamblen	345	69	58,128	0.0012
Bradley	233	103	87,965	0.0012
Davidson	224	482	569,891	0.0008
Washington	500	69	107,198	0.0006
Montgomery	300	69	134,768	0.0005
Rutherford	220	69	182,023	0.0004
Knox	290	103	382,032	0.0003
		SF Holston River		
Buncombe (NC)	170	210	206,330	0.0010
Surry (VA)	200	140	6,829	0.0020
Hamblen	280	210	58,128	0.0036
Russel (VA)	100	140	30,308	0.0046
Greene	96	349	62,909	0.0056
Lee (VA)	145	140	23,589	0.0059
Carter	51	349	56,742	0.0062
Washington (TN)	56	1258	107,198	0.0117
Washington (VA)	30	3004	51,103	0.0588
Sullivan	22	16557	153,048	0.1082

Table 3 (continued)

County	Miles Traveled (roundtrip)	Estimated Trips	2000 Population	Per Capita Visitation Rate
		Watauga River		
Greeneville (SC)	304	114	379,616	0.0003
Gaston (NC)	249	114	190,365	0.0006
Anderson (SC)	300	114	165,740	0.0007
Pickens (SC)	300	114	110,757	0.0010
Greene	80	114	62,909	0.0018
Hawkins	65	227	53,563	0.0042
Avery (NC)	65	114	17,167	0.0066
Watauga (NC)	92	284	42,695	0.0066
Unicoi	32	227	17,667	0.0129
Sullivan	37	4201	153,048	0.0274
Washington	26	4087	107,198	0.0381
Carter	11	5563	56,742	0.0980

Table 4.-Estimated number of trips to the Caney Fork River at additional roundtrip mileage increments.

	Additional Miles								
County	0	100	200	300	400	500	600	700	800
Cheatham	207	60	17	5	1	0	0	0	0
Cumberland	478	138	40	12	3	1	0	0	0
Davidson	5,001	1,447	419	121	35	10	3	1	0
DeKalb	477	138	40	12	3	1	0	0	0
Dickson	146	42	12	4	1	0	0	0	0
Jackson	198	57	17	5	1	0	0	0	0
Macon	234	68	20	6	2	0	0	0	0
Marion	106	31	9	3	1	0	0	0	0
Maury	411	119	34	10	3	1	0	0	0
Montgomery	188	54	16	5	1	0	0	0	0
Putnam	1377	399	115	33	10	3	1	0	0
Rhea	158	46	13	4	1	0	0	0	0
Robertson	323	93	27	8	2	1	0	0	0
Rutherford	2,016	584	169	49	14	4	1	0	0
Smith	549	159	46	13	4	1	0	0	0
Sumner	1,225	355	103	30	9	2	1	0	0
Trousdale	112	32	9	3	1	0	0	0	0
VanBuren	57	16	5	1	0	0	0	0	0
Warren	636	184	53	15	4	1	0	0	0
White	430	125	36	10	3	1	0	0	0
Williamson	848	245	71	21	6	2	0	0	0
Wilson	1,249	361	105	30	9	3	1	0	0
Total Visits	16,426	4,753	1,376	400	114	31	7	1	0

Table 5.-Estimated cost of travel to the eight Tennessee tailwaters. Total cost of travel includes the cost of travel time and vehicle cost.

Added Miles	Time Cost of Travel ($)	Vehicle Cost of Travel ($)	Total Cost of Travel ($)	Total Estimated Trips
		Caney Fork River		
0	0.00	0.00	0.00	16,426
100	14.46	18.16	32.62	4,753
200	28.92	36.32	65.24	1,376
300	43.38	54.47	97.85	400
400	57.84	72.63	130.47	114
500	72.30	90.79	163.09	31
600	86.76	108.95	195.71	7
700	101.22	127.11	228.33	1
800	115.68	145.26	260.94	0
		Clinch River		
0	0.00	0.00	0.00	19,209
50	6.09	10.15	16.24	4,036
100	12.18	20.29	32.47	849
150	18.27	30.44	48.71	178
200	24.36	40.59	64.95	38
250	30.45	50.74	81.19	7
300	36.54	60.88	97.42	1
350	42.63	71.03	113.66	0
		Duck River		
0	0	0.00	0.00	7,938
50	5.49	12.32	17.81	1,720
100	10.98	24.64	35.62	372
150	16.47	36.96	53.43	80
200	21.96	49.29	71.25	17
250	27.45	61.61	89.06	3
300	32.94	73.93	106.87	0

Table 5 (continued)

Added Miles	Time Cost of Travel ($)	Vehicle Cost of Travel ($)	Total Cost of Travel ($)	Total Estimated Trips
		Elk River		
0	0.00	0.00	0.00	1,936
50	7.14	10.78	17.92	646
100	14.28	21.56	35.84	217
150	21.42	32.34	53.76	71
200	28.56	43.13	71.69	23
250	35.70	53.91	89.61	7
300	42.84	64.69	107.53	1
350	49.98	75.47	125.45	0
		Hiwassee River		
0	0.00	0.00	0.00	11,501
50	6.70	9.58	16.28	4,189
100	13.40	19.17	32.57	1,525
150	20.10	28.75	48.85	556
200	26.80	38.33	65.13	202
250	33.50	47.92	81.42	72
300	40.20	57.50	97.70	27
350	46.90	67.08	113.98	9
400	53.60	76.67	130.27	3
450	60.30	86.25	146.55	0
		Obey River		
0	0.00	0.00	0.00	10,717
100	11.96	15.68	27.64	4,534
200	23.92	31.36	55.28	1,920
300	35.88	47.05	82.93	813
400	47.84	62.73	110.57	343
500	59.80	78.41	138.21	146

Table 5 (continued)

Added Miles	Time Cost of Travel ($)	Vehicle Cost of Travel ($)	Total Cost of Travel ($)	Total Estimated Trips
		Obey River (continued)		
600	71.76	94.09	165.85	60
700	83.72	109.77	193.49	25
800	95.68	125.45	221.13	8
900	107.64	141.14	248.78	1
1000	119.60	156.82	276.42	0
		South Fork of the Holston River		
0	0.00	0.00	0.00	9,123
50	4.65	10.15	14.80	4,907
150	13.95	30.44	44.39	1,420
250	23.25	50.74	73.99	411
350	32.55	71.03	103.58	120
450	41.85	91.32	133.17	34
550	51.15	111.62	162.77	10
650	60.45	131.91	192.36	2
750	69.75	152.21	221.96	0
		Watauga River		
0	0.00	0.00	0.00	8,000
100	9.30	19.17	28.47	2,074
200	18.60	38.33	56.93	537
300	27.90	57.50	85.40	140
400	37.20	76.67	113.87	37
500	46.50	95.83	142.33	8
600	55.80	115.00	170.80	2
700	65.10	134.17	199.27	0

Table 6.- Total economic value estimates using the Travel Cost Method for trout fishing opportunities in eight Tennessee tailwaters over comparable 26-week fishing seasons.

River	Number of Trips	Expenditures per Trip($)	Total Expenditures($)	Net Value($)	Total Value($)
Caney Fork	19,952	64.98	1,296,481	485,875	1,782,356
Clinch	24,635	40.03	986,139	238,851	1,224,990
Duck	9,009	41.03	369,639	101,321	470,960
Elk	2,722	54.45	148,213	34,639	182,852
Hiwassee	16,680	90.71	1,513,043	200,789	1,713,832
Obey	8,650	149.15	1,290,148	365,083	1,655,231
SF Holston	24,242	28.71	695,988	235,537	931,525
Watauga	16,859	38.13	642,834	193,539	836,373

Table 7.-Estimated number of trips to the Clinch River at additional roundtrip mileage increments.

	Additional Miles							
County	0	50	100	150	200	250	300	350
Anderson	4,393	923	194	41	9	2	0	0
Blount	951	200	42	9	2	0	0	0
Campbell	1,667	350	74	15	3	1	0	0
Claiborn	277	58	12	3	1	0	0	0
Grainger	103	22	5	1	0	0	0	0
Jefferson	252	53	11	2	0	0	0	0
Knox	9,609	2,019	424	89	19	4	1	0
Loudon	261	55	12	2	1	0	0	0
Morgan	183	38	8	2	0	0	0	0
Roane	421	88	19	4	1	0	0	0
Scott	105	22	5	1	0	0	0	0
Sevier	412	87	18	4	1	0	0	0
Union	575	121	25	5	1	0	0	0
Total Visits	19,209	4,036	849	178	38	7	1	0

Table 8.- Estimated number of trips to the Duck River at additional roundtrip mileage increments.

	Additional Miles						
County	0	50	100	150	200	250	300
Bedford	1,775	384	83	18	4	1	0
Coffee	2,219	481	104	23	5	1	0
Davidson	589	128	28	6	1	0	0
Franklin	827	179	39	8	2	0	0
Marshall	128	28	6	1	0	0	0
Maury	210	45	10	2	0	0	0
Moore	280	61	13	3	1	0	0
Rutherford	1,375	298	64	14	3	1	0
Williamson	535	116	25	5	1	0	0
Total Visits	7,938	1,720	372	80	17	3	0

Table 9.- Estimated number of trips to the Elk River at additional roundtrip mileage increments.

	Additional Miles							
County	0	50	100	150	200	250	300	350
Coffee	229	76	26	9	3	1	0	0
Davidson	188	63	21	7	2	1	0	0
Franklin	406	136	45	15	5	2	1	0
Grundy	36	12	4	1	0	0	0	0
Hamilton	115	39	13	4	1	0	0	0
Lincoln	190	63	21	7	2	1	0	0
Madison (AL)	273	91	31	10	3	1	0	0
Marion	51	17	6	2	1	0	0	0
Maury	91	30	10	3	1	0	0	0
Moore	60	20	7	2	1	0	0	0
Rutherford	225	75	25	8	3	1	0	0
Williamson	72	24	8	3	1	0	0	0
Total Visits	1,936	646	217	71	23	7	1	0

Table 10.- Estimated number of trips to the Hiwassee River at additional roundtrip mileage increments.

	Additional Miles									
County	0	50	100	150	200	250	300	350	400	450
Bradley	1,645	599	218	79	29	11	4	1	1	0
Cobb (GA)	252	92	33	12	4	2	1	0	0	0
Davidson	53	19	7	3	1	0	0	0	0	0
Etowah (AL)	30	11	4	1	1	0	0	0	0	0
Fulton (GA)	335	122	44	16	6	2	1	0	0	0
Gwinnett (GA)	198	72	26	10	3	1	0	0	0	0
Hamilton	2,827	1,030	375	137	50	18	7	2	1	0
Knox	1,772	646	235	86	31	11	4	2	1	0
Marion	74	27	10	4	1	0	0	0	0	0
McMinn	1,591	579	211	77	28	10	4	1	0	0
Meigs	173	63	23	8	3	1	0	0	0	0
Monroe	957	348	127	46	17	6	2	1	0	0
Polk	669	244	89	32	12	4	2	1	0	0
Walker (GA)	283	103	38	14	5	2	1	0	0	0
Whitfield (GA)	642	234	85	31	11	4	1	1	0	0
Total Visits	11,501	4,189	1,525	556	202	72	27	9	3	0

Table 11- Estimated number of trips to the Obey River at additional roundtrip mileage increments.

	Additional Miles										
County	0	100	200	300	400	500	600	700	800	900	1000
Boone (KY)	142	60	25	11	5	2	1	0	0	0	0
Bradley	312	132	56	24	10	4	2	1	0	0	0
Cheatham	93	39	17	7	3	1	1	0	0	0	0
Clay	191	81	34	14	6	3	1	0	0	0	0
Cumberland	412	174	74	31	13	6	2	1	0	0	0
Davidson	2,184	924	391	165	70	30	13	5	2	1	0
Hamblen	79	33	14	6	3	1	0	0	0	0	0
Hamilton	563	238	101	43	18	8	3	1	1	0	0
Haywood	10	4	2	1	0	0	0	0	0	0	0
Jackson	172	73	31	13	6	2	1	0	0	0	0
Knox	833	352	149	63	27	11	5	2	1	0	0
Macon	260	110	47	20	8	4	1	1	0	0	0
Marion	89	38	16	7	3	1	1	0	0	0	0
Monroe (KY)	245	104	44	19	8	3	1	1	0	0	0
Montgomery	270	114	48	20	9	4	2	1	0	0	0
Overton	356	151	64	27	11	5	2	1	0	0	0
Pickett	78	33	14	6	2	1	0	0	0	0	0
Putnam	863	365	155	65	28	12	5	2	1	0	0

Table 11 (continued)

	Additional Miles										
County	0	100	200	300	400	500	600	700	800	900	1000
Rhea	137	58	25	10	4	2	1	0	0	0	0
Roane	259	110	46	20	8	4	1	1	0	0	0
Robertson	254	107	45	19	8	3	1	1	0	0	0
Rutherford	725	307	130	55	23	10	4	2	1	0	0
Sequatchie	35	15	6	3	1	0	0	0	0	0	0
Sumner	898	380	161	68	29	12	5	2	1	0	0
Washington	38	16	7	3	1	1	0	0	0	0	0
White	251	106	45	19	8	3	1	1	0	0	0
Williamson	458	194	82	35	15	6	3	1	0	0	0
Wilson	510	216	91	39	16	7	3	1	1	0	0
Total Visits	10,717	4,534	1,920	813	343	146	60	25	8	1	0

Table 12.- Estimated number of trips to the South Fork of the Holston River at additional roundtrip mileage increments.

	Additional Miles								
County	0	50	150	250	350	450	550	650	750
Buncombe (NC)	777	418	121	35	10	3	1	0	0
Carter	932	501	145	42	12	4	1	0	0
Greene	600	323	93	27	8	2	1	0	0
Hamblen	56	30	9	3	1	0	0	0	0
Lee (VA)	121	65	19	5	2	0	0	0	0
Russel (VA)	272	146	42	12	4	1	0	0	0
Sullivan	3,606	1,940	561	162	47	14	4	1	0
Surry (VA)	18	10	3	1	0	0	0	0	0
Washington	1,655	890	258	75	22	6	2	1	0
Washington (VA)	1,086	584	169	49	14	4	1	0	0
Total Visits	9,123	4,907	1,420	411	120	34	10	2	0

Table 13.- Estimated number of trips to the Watauga River at additional roundtrip mileage increments.

	Additional Miles							
County	0	100	200	300	400	500	600	700
Anderson (SC)	74	19	5	1	0	0	0	0
Avery (NC)	183	48	12	3	1	0	0	0
Carter	1,251	324	84	22	6	1	0	0
Gaston (NC)	169	44	11	3	1	0	0	0
Greene	548	142	37	10	2	1	0	0
Greeneville (SC)	161	42	11	3	1	0	0	0
Hawkins	572	148	38	10	3	1	0	0
Pickens (SC)	50	13	3	1	0	0	0	0
Sullivan	2,375	616	160	41	11	3	1	0
Unicoi	294	76	20	5	1	0	0	0
Washington	1,937	502	130	34	9	2	1	0
Watauga (NC)	386	100	26	7	2	0	0	0
Total Visits	8,000	2,074	537	140	37	8	2	0

Table 14.-Contingent valuation models for trout fishing opportunities in eight Tennessee tailwaters.

Angling Scenario	Number of Responses	Significant Variables	Parameter Estimate	p-value	Adjusted r^2
		Caney Fork River			
Current Conditions	366	$\log_e$(bid)	-1.0826	0.0001	0.41
		income	9.22E-06	0.0334	
More Trout	383	loge(bid)	-1.2636	0.0001	0.47
		expenditures	0.0037	0.0189	
Large Trout	394	bid	-0.0182	0.0001	0.47
		trip length	0.4478	0.0158	
Flows	280	$\log_e$(bid)	-0.7687	0.0001	0.35
		income	1.40E-05	0.0035	
		Clinch River			
Current Conditions	575	$\log_e$(bid)	-1.0558	0.0001	0.42
		income	1.20E-05	0.0009	
More Trout	575	$\log_e$(bid)	-0.9243	0.0001	0.35
		income	8.47E-06	0.0139	
Large Trout	575	$\log_e$(bid)	-0.8675	0.0001	0.34
		income	1.20E-05	0.0006	
Flows	574	$\log_e$(bid)	-0.8889	0.0001	0.35
		Duck River			
Current Conditions	126	$\log_e$(bid)	-1.2119	0.0001	0.50
		expenditures	0.0172	0.0430	
More Trout	126	$\log_e$(bid)	-1.3489	0.0001	0.54
		expenditures	0.0208	0.0197	
Large Trout	126	$\log_e$(bid)	-1.2244	0.0001	0.49
		expenditures	0.0216	0.0147	

Table 14 (continued)

Angling Scenario	Number of Responses	Significant Variables	Parameter Estimate	p-value	Adjusted r^2
		Elk River			
Current Conditions	136	$\log_e$(bid)	-1.1567	0.0001	0.41
		income	1.60E-05	0.0105	
More Trout	136	$\log_e$(bid)	-1.1973	0.0001	0.42
		income	2.30E-05	0.0005	
Large Trout	136	$\log_e$(bid)	-1.1841	0.0001	0.39
		income	1.80E-05	0.0047	
Flows	141	$\log_e$(bid)	-0.6949	0.0001	0.24
		Hiwassee River			
Current Conditions	290	$\log_e$(bid)	-1.3807	0.0001	0.56
		income	2.40E-05	0.0002	
More Trout	312	$\log_e$(bid)	-1.5109	0.0001	0.57
		expenditures	4.43E-03	0.0002	
Large Trout	310	bid	-0.0220	0.0001	0.46
		$\log_e$(expenditures)	0.5245	0.0003	
Flows	253	bid	-0.0184	0.0001	0.40
		income	1.70E-05	0.0107	
		Obey River			
Current Conditions	297	$\log_e$(bid)	-1.2051	0.0001	0.47
		expenditures	0.0052	0.0001	
More Trout	266	$\log_e$(bid)	-0.9531	0.0001	0.33
Large Trout	297	$\log_e$(bid)	-1.0709	0.0001	0.39
		expenditures	0.0030	0.0010	
Flows	208	$\log_e$(bid)	-0.5884	0.0001	0.30
		miles	0.0039	0.0001	

Table 14(continued)

Angling Scenario	Number of Responses	Significant Variables	Parameter Estimate	p-value	Adjusted r^2
		SF Holston River			
Current Conditions	298	$\log_e$(bid)	-1.0002	0.0001	0.45
		income	2.80E-05	0.0001	
More Trout	299	$\log_e$(bid)	-1.3611	0.0001	0.54
		income	2.40E-05	0.0005	
Large Trout	299	$\log_e$(bid)	-1.2416	0.0001	0.51
		income	2.60E-05	0.0001	
Flows	292	$\log_e$(bid)	-1.0258	0.0001	0.43
		income	1.40E-05	0.0297	
		Watauga River			
Current Conditions	260	$\log_e$(bid)	-0.8352	0.0001	0.37
		income	1.80E-05	0.0015	
More Trout	261	$\log_e$(bid)	-1.0518	0.0001	0.44
		income	1.70E-05	0.0047	
Large Trout	261	$\log_e$(bid)	-0.9371	0.0001	0.40
		income	1.30E-05	0.0213	
Flows	253	$\log_e$(bid)	-0.8628	0.0001	0.40
		income	2.00E-05	0.0004	

Table 15.- Net value estimates for trout fishing opportunities in Tennessee tailwaters obtained with the contingent valuation method. Values shown are U.S. dollars per angler per day.

Tailwater	Current Conditions	More Trout	Large Trout	Predictable Flows
Caney Fork	$64.31	$91.09	$93.31	$51.50
Clinch	$54.43	$84.58	$117.30	$61.16
Duck	$42.27	$47.57	$61.10	***
Elk	$61.14	$86.70	$159.77	$38.07
Hiwassee	$55.27	$68.02	$67.79	$58.49
Obey	$47.00	$48.18	$50.18	$32.73
SF Holston	$57.09	$72.13	$64.87	$36.97
Watauga	$91.69	$116.00	$109.12	$46.09

Table 16.- Percent changes in net value from current conditions for various trout fishing scenarios as obtained with the contingent valuation method.

Tailwater	More Trout	Large Trout	Predictable Flows
Caney Fork	42	45	-20
Clinch	55	116	12
Duck	13	45	***
Elk	42	161	-38
Hiwassee	23	23	6
Obey	3	7	-30
SF Holston	26	14	-35
Watauga	27	19	-50

Table 17.-Comparison of net value estimates obtained from the travel cost and contingent valuation methods. Values are given in U.S. dollars per angler per day.

River	TCM	CVM
Caney Fork	$17.90	$64.31
Clinch	$7.35	$54.43
Duck	$10.04	$42.27
Elk	$10.97	$61.14
Hiwassee	$9.55	$55.27
Obey	$14.02	$47.00
SF Holston	$8.60	$57.09
Watauga	$9.98	$91.69

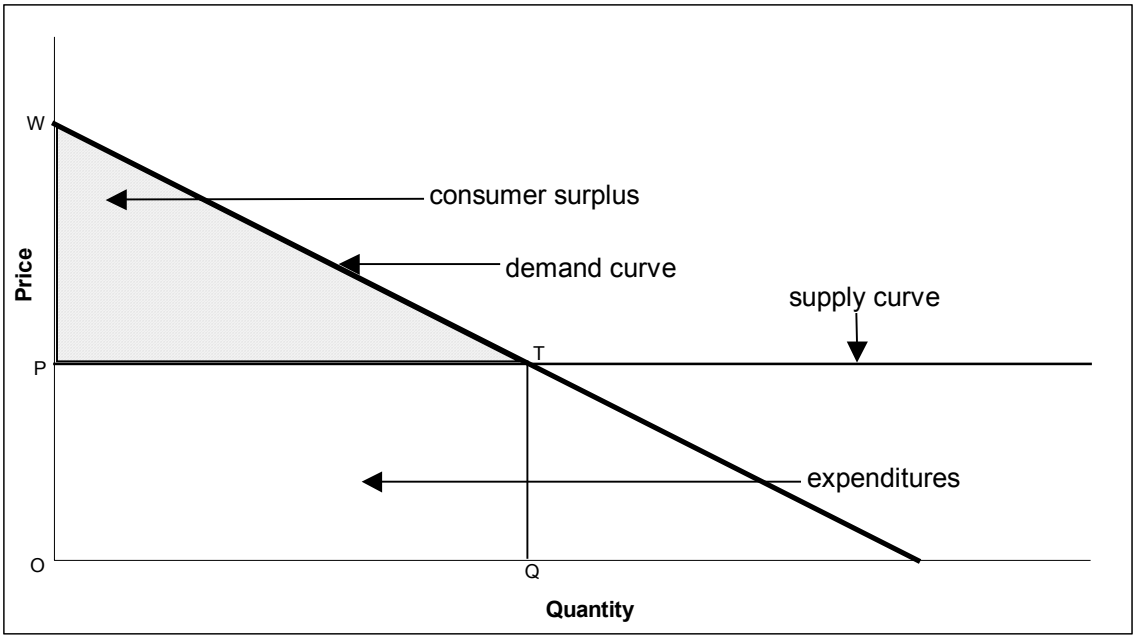

Figure 1. Generalized supply and demand curves showing consumer surplus as the shaded, triangular area. Point P is the cost of participating in the activity and Point Q indicates the number of trips that will be taken at that cost. (Adapted from Pollock et al. 1994).

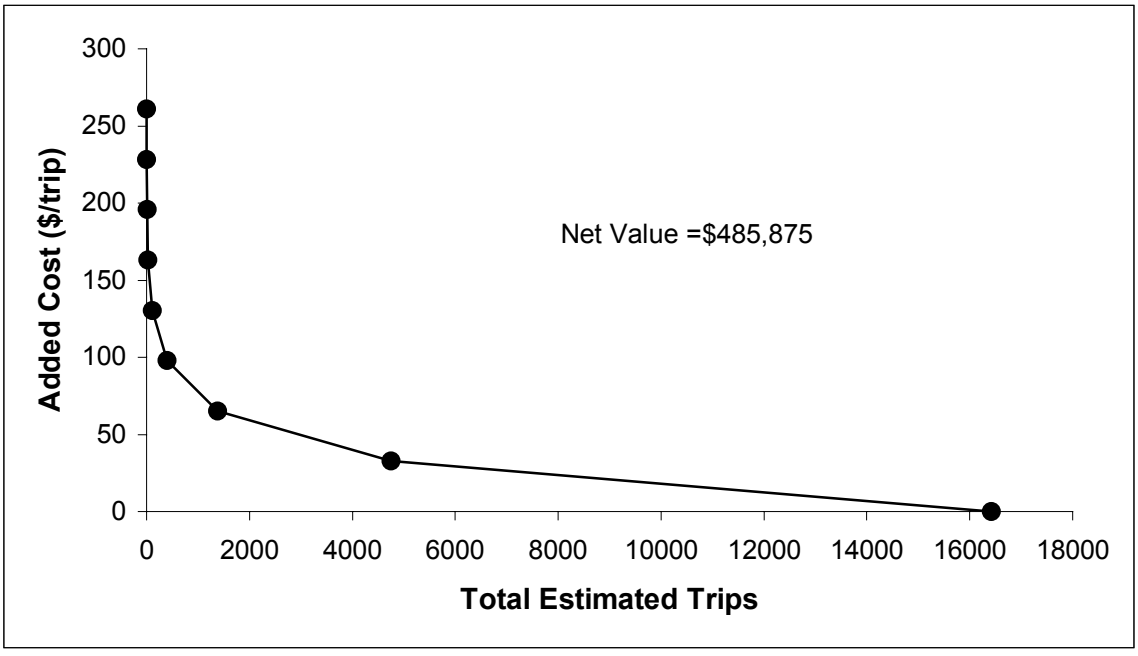

Figure 2. Second-stage demand curve for visitation to the Caney Fork River.

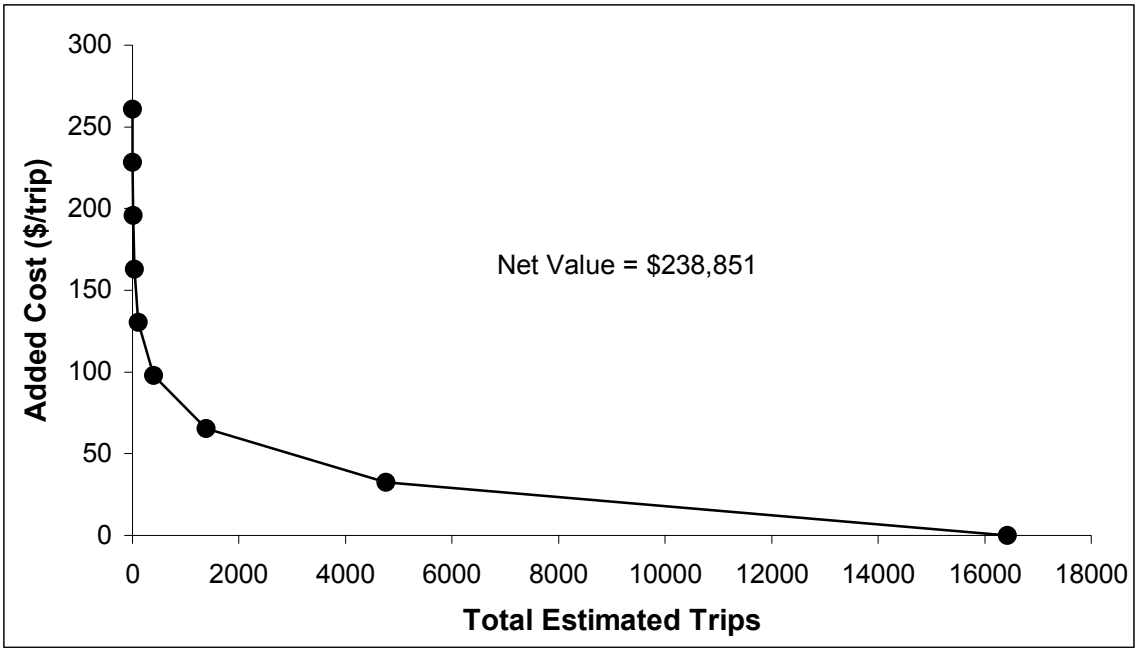

Figure 3. Second-stage demand curve for visitation to the Clinch River.

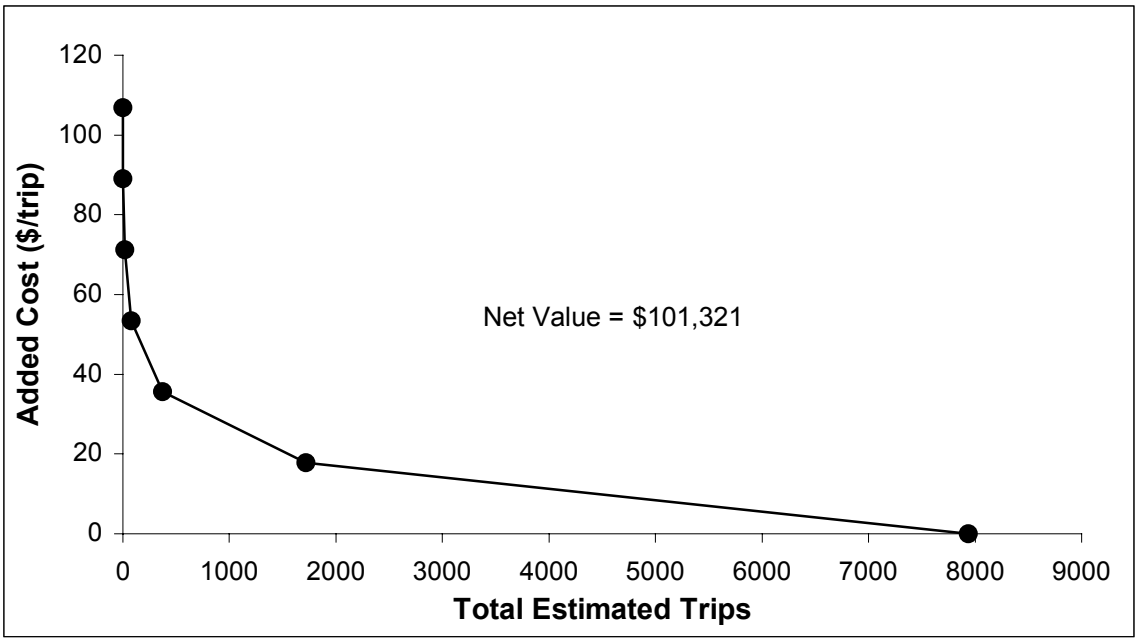

Figure 4. Second stage demand curve for visitation to the Duck River.

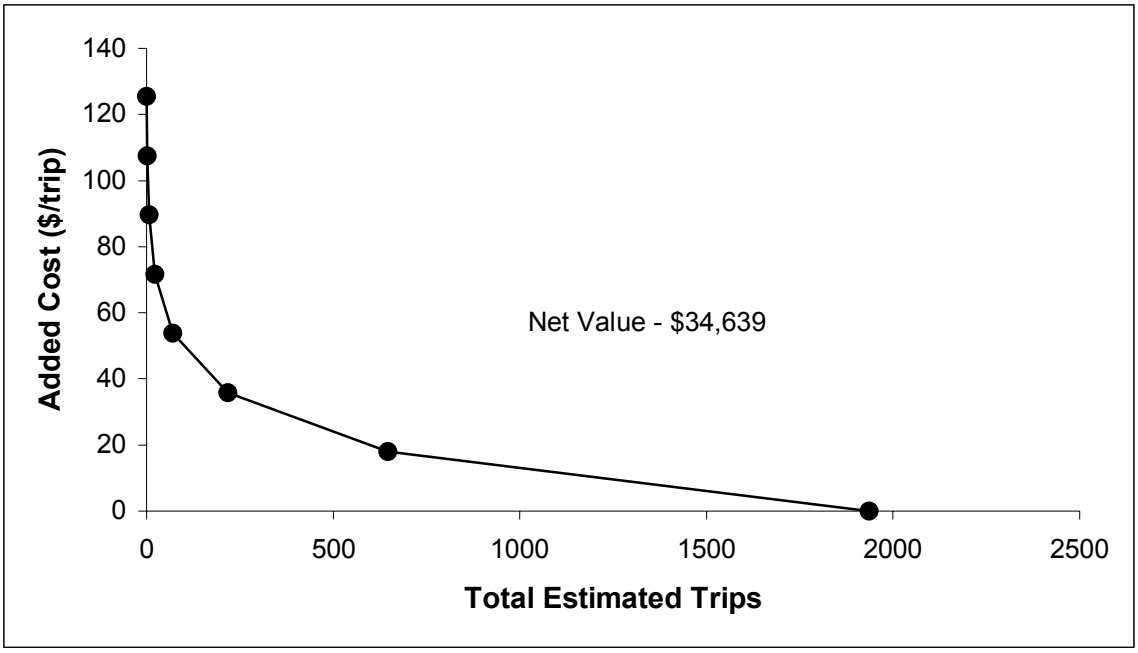

Figure 5. Second-stage demand curve for visitation to the Elk River.

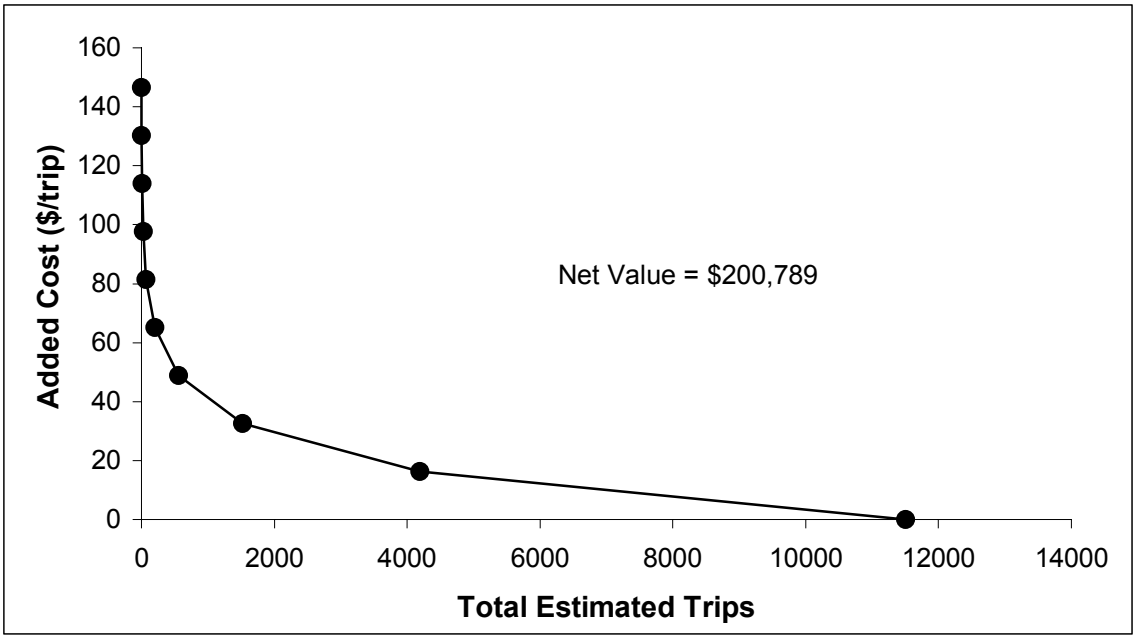

Figure 6. Second-stage demand curve for visitation to the Hiwassee River.

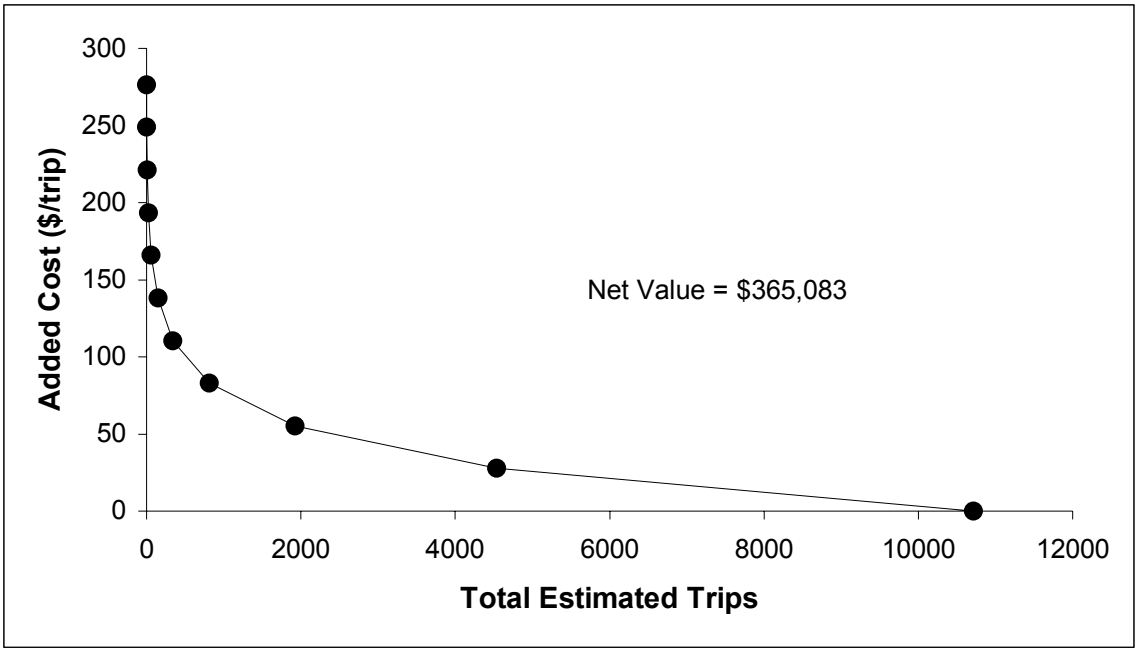

Figure 7. Second-stage demand curve for visitation to the Obey River.

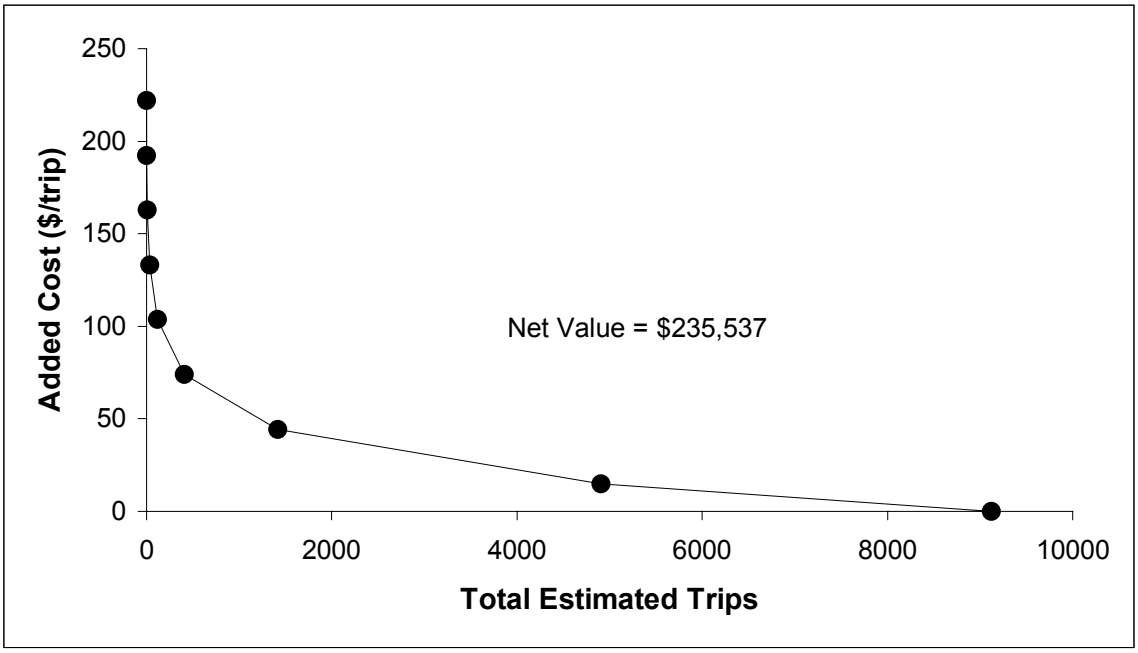

Figure 8. Second-stage demand curve for visitation to the South Fork of the Holston River.

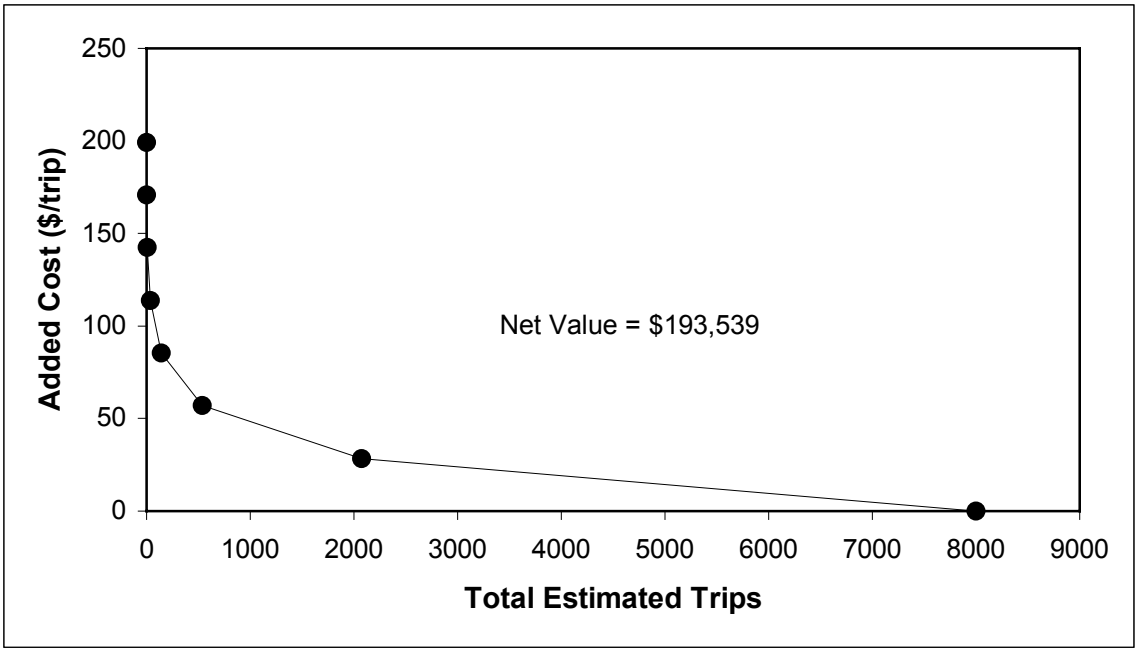

Figure 9. Second-stage demand curve for visitation to the Watauga River.

APPENDIX

Survey Instrument Used to Collect Visitation and Expenditure Data on Anglers Fishing Eight Tennessee Tailwater Trout Fisheries

River Angler Interview Form

"Hello, my name is _____ and I'm conducting a survey for the Tennessee Wildlife Resources Agency to understand why anglers decide to fish this river and to determine the economic value of this fishery. May I ask you some questions about your fishing trip today?" (If no, thank them and leave)

Date_____ Time_____ Angler ID #_____

Recorder's Initials_____ Weather _____

River_____ # in party_____

1.) Fishing method: bait___ lure___ fly___ Fishing from: shore___ wading___ boat___

2.) What species of trout are you fishing for? Rainbow_____ Brown_____ Both_____

3.) How long have been fishing today? _____ hours _____minutes

4.) How many trout have you caught today? _____Rainbow(s) _____Brown(s)

" I would now like to ask some questions dealing with how much money you will spend on this trip and the value you place on fishing this river."

5.) Is fishing this river the primary purpose of your trip to this area?
Yes_____ No_____

6.) How many days will your trip last? _____ days

7.) Including today, how many days have you fished this river for trout in the last twelve months?
_____ days

8.) Where did your trip originate?
County _____ State_____ Zip Code _____

9.) About how many miles did you travel from your home to this river? _____ miles

10.) How much time did you spend traveling from your home to this river?
_____ hours _____ minutes

11.) What type of transportation did you use to travel here?
Car_____ Truck_____ Other (please specify)_____

12.) How much do you expect to spend on this trip for each of the following items?
Food/drink $_____ Lodging $_____ Guide service $_____
Bait/tackle (items for this trip only) $_____ Other (items for this trip only) $_____

"The following questions will be used to estimate the economic value of the trout fishery at this river. The questions are hypothetical and are not linked to the cost of a fishing license."

13.) If the trout fishing conditions you experienced today were unchanged, but the cost to make this trip had been _____ higher than what you actually spent, would you still have made the trip? Yes_____ No_____

14.) If you were twice as likely to catch twice as many trout on this trip, but the cost to make this trip was _____ higher than what you actually spent, would you still have made the trip? Yes_____ No_____

15.) If you were twice as likely to catch a trout larger than 16 inches on this trip, but the cost to make this trip was _____ higher than what you actually spent, would you still have made the trip? Yes_____ No_____

16.) If the cost to make a trip were _____ higher than what you spent today, but there was no chance of having to stop or cancel the trip due to unpredictable flows, would you still make the trip? Yes_____ No_____

"The next three questions pertain to your preferences regarding the size and number of fish you catch."

17.) On a scale of 1 to 5, how would you rate your satisfaction with a catch or harvest of ____ trout this size, where 1 means least satisfied and 5 means most satisfied? ____

18.) On the same scale, how would you rate your satisfaction with a catch or harvest of ____ trout this size? ____

19.) On the same scale, how would you rate your satisfaction with your typical catch or harvest on this river? ____

"I would like to conclude the survey with some questions that will allow us to characterize the trout anglers who fish this river."

20.) Gender: Male _____ Female _____ **21.)** What is your age? _____

22.) What is your marital status? Single_____ Married_____ Other_____

23.) What is the highest level of education you have completed?

_____ Some high school _____ High school diploma _____ Vocational or technical degree

_____ Some college _____ College degree _____ Post graduate degree

24.) Please designate the letter on this card that best designates your total household income last year before taxes.

Response from card _____

25.) How many years of trout fishing experience do you have? _____ years

"Thank you very much for your time. Your assistance is greatly appreciated. Have a good day."